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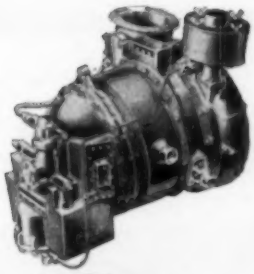

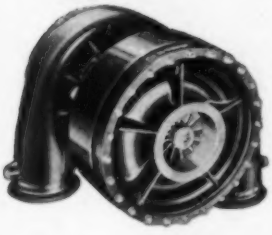

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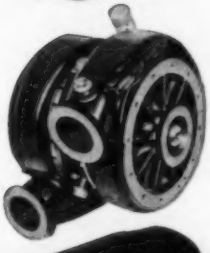

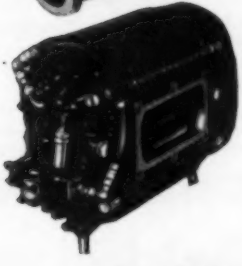

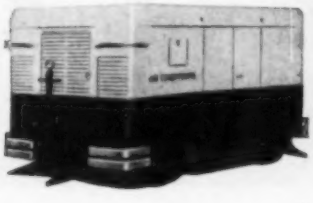

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A

A leap in the dark!

"'TIS THE ROUNDHEADS, Sir Percy. Haste thee, Milord — jump for it!"

"But 'tis dark outside," said Sir Percy plaintively — off the battlefield he was a man of cautious disposition — "'tis wondering where to jump I am?"

"'Tis no time to ponder" retorted the Squire, "Haste!"

"Very well then, I suppose thou knowest best." Sir Percy grasped his sword, swung his cloak, and leapt into a world of darkness; he was pleasantly surprised to land on something soft and yielding. "Gad!" he beamed, "the age of miracles is not yet past." From beneath him, oddly muffled, the Squire's voice choked; "'Twould be uncommon kind of milord to remove his scabbard from the small of my back."

"Faith!" cried the cavalier — "here is a waggish situation indeed. Meseems I made a splendid landing on thy broad and faithful back. And where didst *thou* come to earth, old friend?"

The Squire squirmed uneasily. "Verily I could not swear to it, but if I mistake me not, we are in the cattleyard." His movements were accompanied by an odd squelching sound. "Verily thou wert unfortunate," said Sir Percy with soldierly sympathy — "perhaps that will teach thee the folly of a spring in the dark. And speaking of springs" — he spake with a knowledge surprising in one of that period — "Didst know that the most inferior springs may look exactly like a genuine high precision job, guaranteed for years of high performance? What! not interested in springs? Ah, well, perhaps a tub would suit thee better." He ambled off into the darkness . . .

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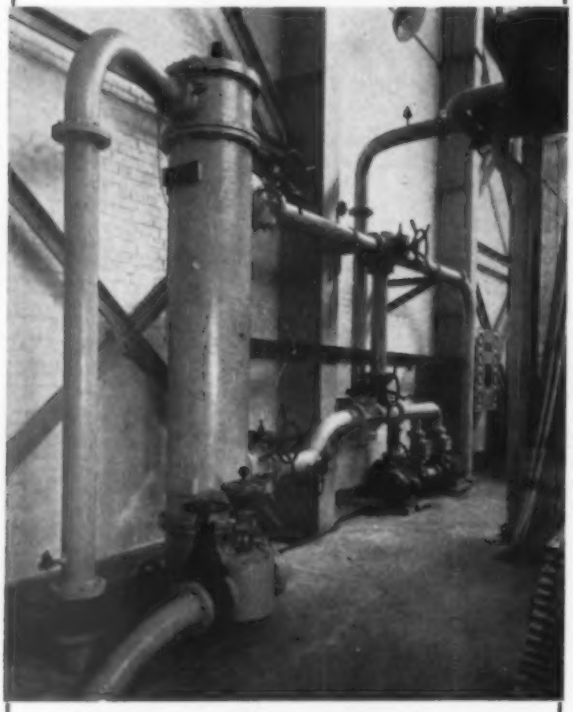

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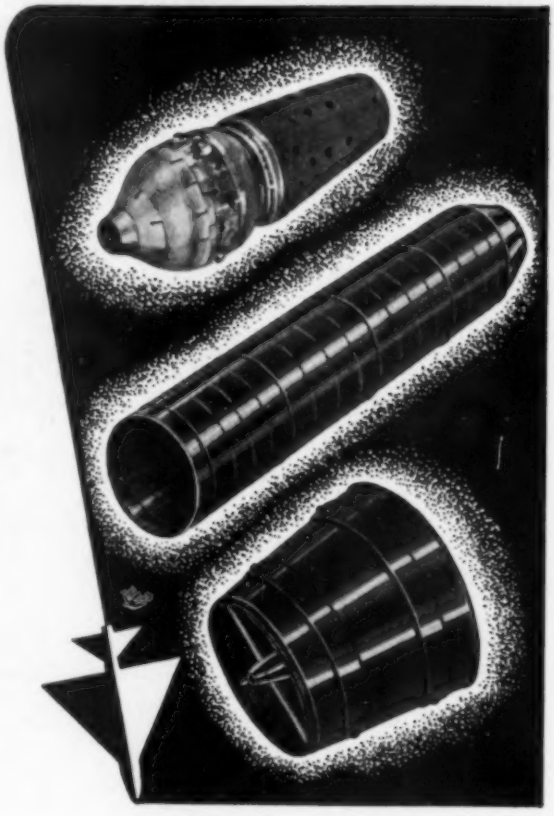

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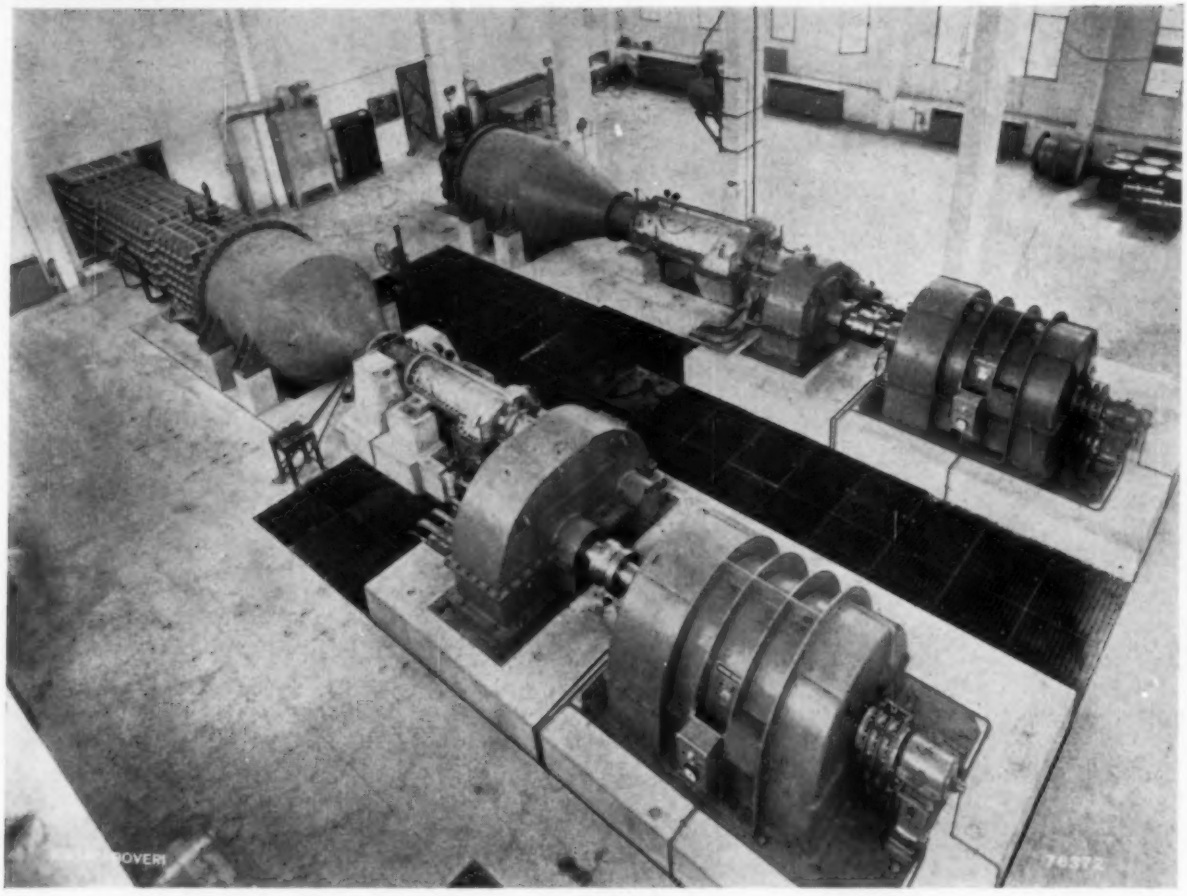

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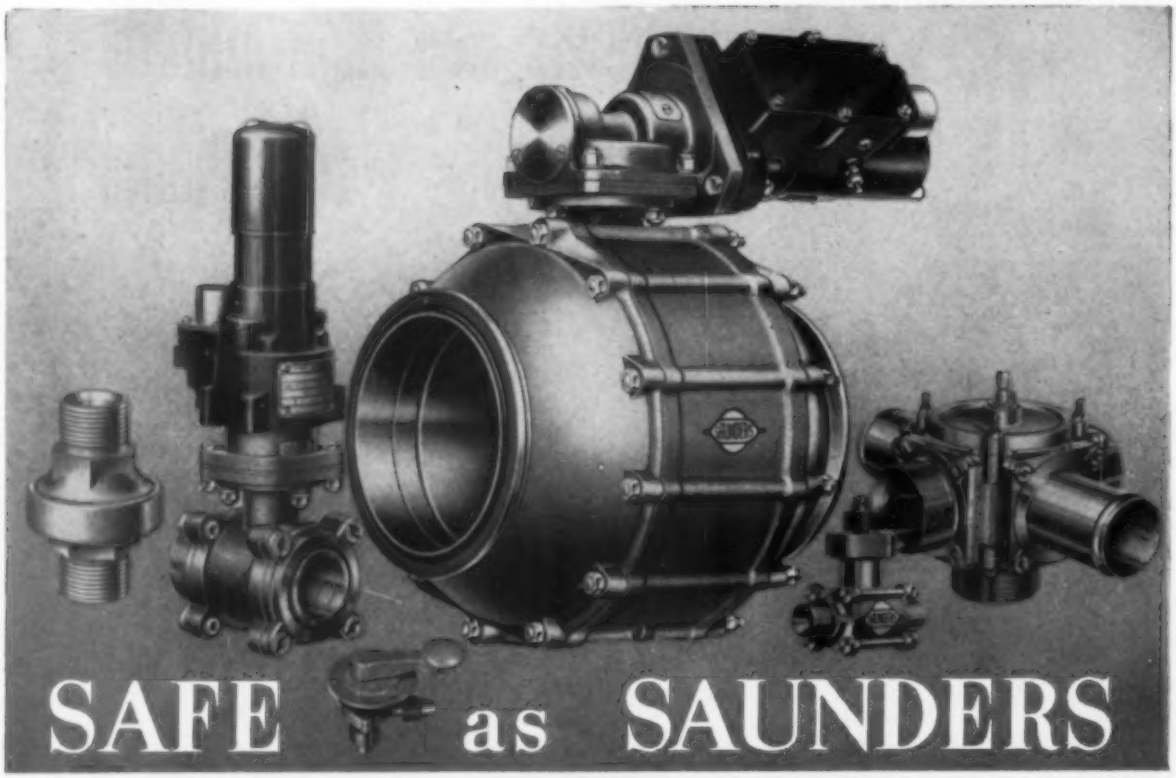

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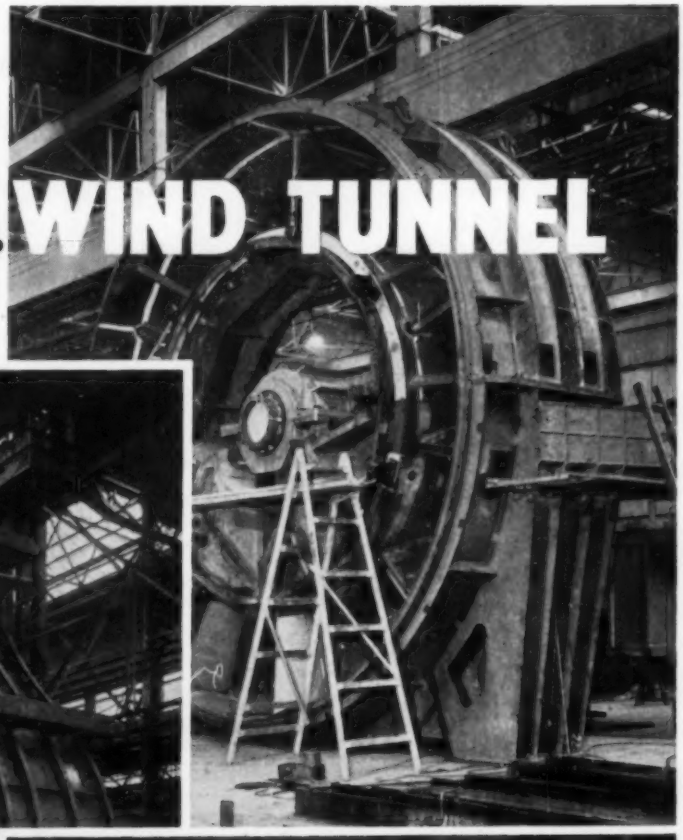

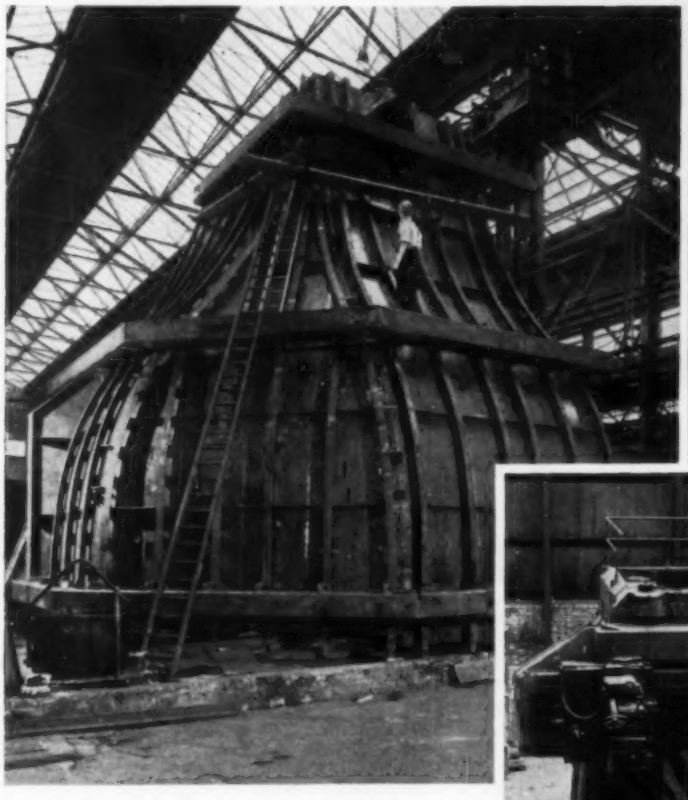

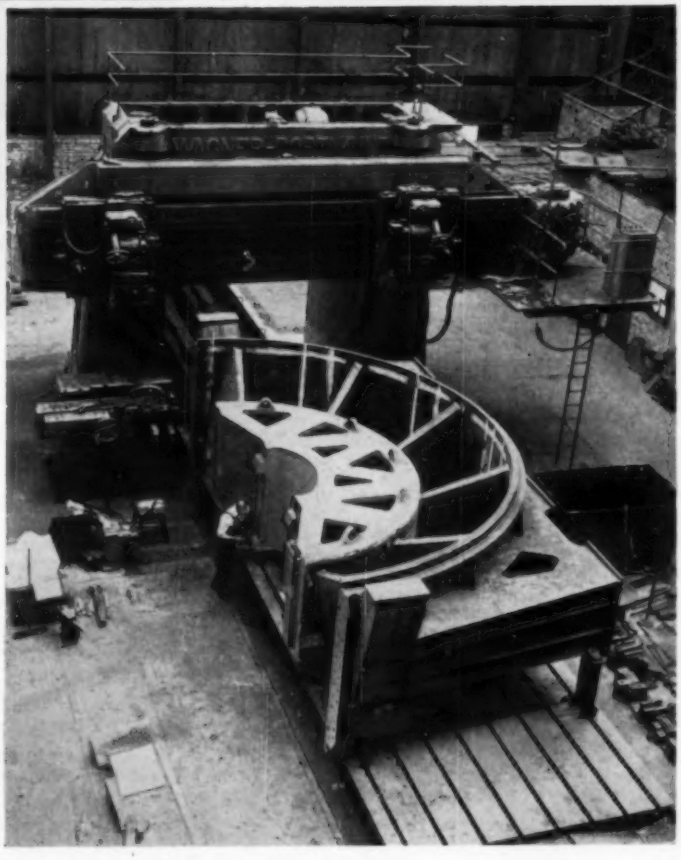

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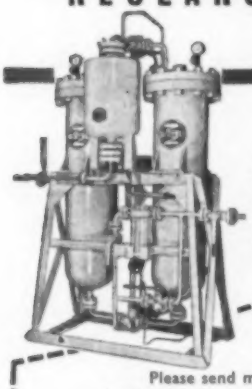

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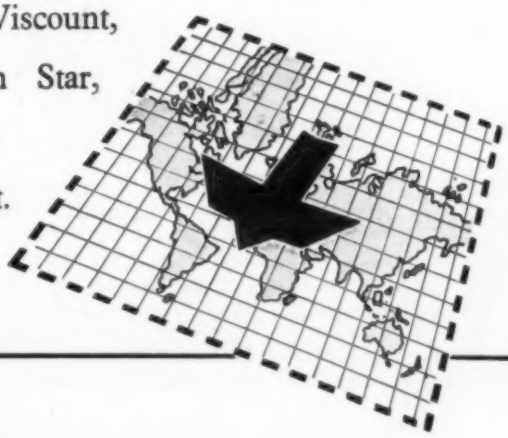

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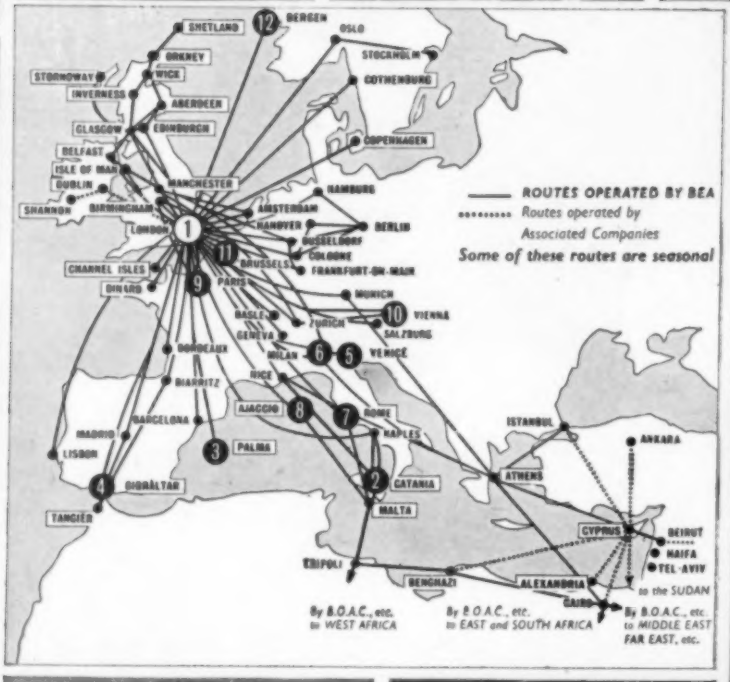
The BEA historical map of Europe



1. *Sir Walter Raleigh (1552-1618) pioneer of the English colonies.*
2. *Garibaldi leading his "Thousand" in Sicily, 1859.*
3. *Chopin and George Sand who went to Majorca in 1838.*
4. *The English fleet under Admiral Rooke capturing Gibraltar, 1704.*
5. *Marco Polo (1254-1324), Venetian explorer, on his way back from China.*
6. *Frederick Barbarossa, German Emperor, entering Milan, 1162.*
7. *The Roman Emperor Caligula (A.D. 37-41), who declared his horse Incitatus a priest and a consul.*
8. *Napoleon, born in Corsica in 1769, on board H.M.S. Bellerophon after his defeat at Waterloo.*
9. *The French Revolution, 1789. Storming of the Bastille.*
10. *Johann Strauss (1825-1899), Viennese composer of the "Blue Danube" and many other waltzes.*
11. *The Duke of Wellington at the Battle of Waterloo (1815).*
12. *Amundsen, Norwegian explorer, on his way to the South Pole (1911).*

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FIRST AERONAUTICAL WEEKLY IN THE WORLD FOUNDED 1909

FLIGHT
and
AIRCRAFT ENGINEER

No 2467 Vol 69 FRIDAY 4 MAY 1956

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Concrete Proposals

WERE a shipping company to ask for the Suez Canal to be widened and deepened, it would doubtless be told to go to the Cape of Good Hope—or buy smaller ships. No doubt maritime commerce would benefit immensely were the Suez Canal given Cunarder dimensions; but we leave that question to be debated by the seafarers. The motion before the airfarers is: should airports be made to fit airliners, or *vice versa*?

During its short history aviation has repeatedly met problems which threatened its progress—and which would have actually impeded it had the "man-with-a-red-flag" mentality prevailed. Invariably in the end the tune that is played is the one called by the operator. There will always be people who, when a new note is struck, put their fingers in their ears and groan; the designers should, they protest, build aircraft which "fall in with the existing pattern" (or some such phrase). Their cries can be heard at the moment, even above the mighty percussion of the DC-8 and Boeing 707 symphonies now being conducted on the west coast of the United States of America.

On pages 524 to 528 of this issue an analysis of the way in which the world's runways measure up to the DC-8 and the Boeing 707 is not a subscription to the views of the Doubting Thomases; rather is it an attempt to show what the world has to do before it will be ready for these aircraft. There are other problems, not discussed in the article, which also have to be met squarely and immediately. What airports, it has been asked, have the facilities to process 140 passengers at a time? Or the hydrant fuel installations to replenish 18,000-gallon tanks for a quick turn-round? Or the radar to relieve choked airspace?

As a postscript, it may be added that our quest for data on the world's runways took us to the Aeronautical Information Service of the Ministry of Transport and Civil Aviation: our demands brought efficient and courteous service. These people do a first-rate job for British aviation, and we would like to think that every penny of the income tax we pay goes to departments as capable as this.

Research at the Co-op

SOME sections of the British aircraft industry are by now becoming a little tired of being incessantly exhorted to pool their resources. More than in most countries we are "a nation of shopkeepers," and it is not in the nature of things that a number of shops should join forces owing to their incapacity to satisfy the customer individually.

But, unfortunately, the R.A.F., the Royal Navy and the British airline Corporations are by no means normal customers; their proper equipment is a matter which affects our safety on the one hand and our prosperity on the other. It has been increasingly clear in recent years that a number of individual "shops" will have to suffer a certain amount of amalgamation if the complex products demanded by these customers are to be delivered on time and in working order.

For this reason we cannot conceal our satisfaction that His Royal Highness the Duke of Edinburgh was today due to open a wind tunnel in Bedford; not an earth-shaking event perhaps, but one which is brought more clearly into perspective by the fact that fourteen of our biggest aircraft companies clubbed together to find almost £1½ million to pay for the tunnel and thus to enjoy something which they would not otherwise have been able to afford. The installation is fully described on pages 534-539.

Let us not, however, blow our trumpet too loudly. Last week there came from America an account of the opening ceremony of a new *40,000 h.p. addition* to the Southern California Co-operative Wind Tunnel (owned jointly by Douglas, Convair, Lockheed and North American). This tunnel was originally dedicated and placed in operation in May, 1945; if only the A.R.A. tunnel had been also . . .

FROM ALL QUARTERS

Offshore Sea Hawks

AN agreement was signed last week for the construction of Hawker Sea Hawk aircraft and spares under the U.S. offshore procurement programme. Worth $6,429,000 (more than £2½m), the order is understood to be for Holland, and it is believed that another order for the supply of Sea Hawks to Germany may follow. The aircraft are to be built by Armstrong Whitworth, who have been responsible for the development and production of Sea Hawks, from Sir Sydney Camm's original design, since 1953.

Export Record

EXPORTS of British aircraft and accessories during March reached an all-time high level; moreover, the figure was some 77 per cent higher than any previously recorded for a single month. The March value amounted to £14,093,202—approximately the same as for the first *three* months of 1955. The new record figure is £6,043,895 more than for the previous record month, February, and it brings the 1956 total to date to £29,287,505—already nearly half the total for the whole of 1955.

Australia, with £5,797,478, was Great Britain's best customer, with the United States runner-up with £1,423,010, worth some $4m. Of the remaining 28 major countries who bought our aeronautical products, Sweden (£533,785), France (£329,665), and New Zealand (£115,858) were the next best customers.

Nocturnal Whirlwind

LAST Friday, at Yeovil, tests were made which it was hoped would lead to approval being given for night flying of the Westland Whirlwind helicopter. A.R.B. officials watched one of these aircraft make a series of engine-off landings by the light of parachute flares. The pilot, Lt-Cdr. Roy Bradley (Westland assistant chief pilot) climbed to 1,000ft and released, from a fitting located at the rear of the fuselage, a Schermuly flare of 75 sec burning duration. Simultaneously, he switched off the engine and prepared for an autorotative descent. At 500ft he released a 45-sec flare and continued his descent to a successful landing. This demonstration was repeated a number of times.

Like fixed-wing aircraft, helicopters are—or can be—fitted with orthodox night flying equipment, consisting of navigation lights and landing lamps; the flare technique has been devised for use in the event of engine failure.

"Very Good Motors"

AS shown by a picture on this page, Mr. A. N. Tupolev, the distinguished Russian aircraft designer, visited the Bristol Aeroplane Company at Filton on April 24th. He arrived in a de Havilland Devon belonging to the Ministry of Supply and was accompanied by Mr. Kruschev's student son, members of his own staff, and Foreign Office and M.o.S. officials. Lunch was taken with Sir Reginald Verdon Smith, chairman of the Bristol Aeroplane Company, Sir Alec Coryton, chairman and managing director of Bristol Aero-Engines, and Dr. Stanley Hooker, director and chief engineer of Bristol Aero-Engines, Ltd.

Having visited the engine division, Mr. Tupolev said through an interpreter, "We have seen the excellent engines made by this firm," adding, "very good motors they are, too." Before returning to London in the afternoon the party inspected a Britannia (which Mr. Tupolev had already seen at London Airport), and made a brief tour of the aircraft division. His technical questions were answered by Dr. A. E. Russell and Mr. C. F. Uwins, respectively chief engineer and chairman of Bristol Aircraft, Ltd.

"TU" AT BRISTOL: Mr. A. N. Tupolev, designer of some of Russia's finest civil and military aircraft, seen (centre) at Filton House with Sir Reginald Verdon Smith and Dr. Stanley Hooker during his Bristol visit on April 24th, as described on this page.

MARINE MONSTER: A fearsome aspect of the Supermarine N.113 twin-Avon naval fighter on the steam-catapult of H.M.S. "Ark Royal." Carrier trials are the subject of a news item on page 548. Note the tail-down launching attitude. (No actual launches took place.)

Frederick B. Rentschler

WE record with regret the death, on April 25th, of Mr. Frederick B. Rentschler, founder of the Wright and Pratt and Whitney engine companies and chairman of the United Aircraft Corporation. He was 68.

Mr. Rentschler.

The creation of horsepower, it is said, absorbed his attention from boyhood. His school vacations found him working in his father's plant at Hamilton, Ohio, as a puddler in the making of castings for steam and gas engines. Later he was engaged in the manufacture of cars, with special emphasis on their engines, and during World War I he was appointed a Government representative at the Wright-Martin engine plant at New Brunswick. Soon after the Armistice Mr. Rentschler formed the Wright Aeronautical Corporation, became its first general manager and vice-president, and soon thereafter president. During his administration the company developed several engines of its own, took over the Lawrance radial and laid the groundwork for the near-fabulous Whirlwind. In 1924, for family reasons, he resigned as president and returned to Hamilton.

In the spring of 1925 Rentschler learned that the Navy wanted a dependable radial of 400 h.p., weighing 600 lb or less. In Hartford was a factory then being used as a tobacco warehouse; its owners had money and, moreover, the Connecticut valley and New England offered the finest skills in the machine and tool-making trade. Rentschler arranged a loan of $250,000, secured the plant and with George J. Mead formed the Pratt and Whitney Aircraft Company. Then with Mead and the late Donald S. Brown (who eventually became president of P. and W. and then of United Aircraft) Rentschler went to Hartford, and by December 1925, the new engine—the Wasp—was running. Although the first Wasp sales were to the Navy, the engine attracted attention elsewhere. The Boeing company, for instance, bought 24 for a new mail and passenger machine—an order which marked the entry of the young company into the commercial field. In October 1928, Pratt and Whitney joined in a merger with Boeing and Boeing Airlines to form the United Aircraft and Transport Corporation. Rentschler became president, and out of the dissolution of the corporation came three companies—Boeing Airplane, United Airlines and United Aircraft Corporation.

A United Aircraft spokesman remarks: "Mr. Rentschler, in 1935, became chairman of this company, which continues today much as it was set up then. As chairman, Mr. Rentschler did not

THE BACK PORCH: In animated discussion with A.V-M. H. N. Thornton (back to aircraft) General Milch (hatless) is seen by the rear entrance to the Blackburn Beverley on the occasion of its recent visit to Germany *(see paragraph on page 548).*

TUG DE LUXE: First flight of the Martin B-57E target tug, being developed to provide air-to-air and ground-to-air firing practice. Another recent first flight was that of the RB-57D, with Pratt and Whitney J57 two-spool turbojets.

spend so much time on the actual operations of the company and was able to devote more attention to planning for the future."

In 1951, the French Government made Mr. Rentschler an officer of the Legion of Honour for his "contribution to the progress of aeronautical science." Trinity College of Hartford, Connecticut, conferred on him the degree of Doctor of Laws as the man "who helped America to gain air supremacy and keep it when jet propulsion revolutionized air power."

Celebrating 1,132 m.p.h.

GUESTS at a luncheon at Claridge's Hotel, London, on April 26th felt privileged to share in the celebration of the recent establishment of a new world speed record by Peter Twiss in the Fairey F.D.2. The Duke of Edinburgh headed a guest list which included many of the leading figures in civil and military aviation and the aircraft industry.

There were only two formal speeches: the toast of the Fairey company, by Mr. Maudling, M.P., Minister of Supply, and the response by Sir Richard Fairey. Mr. Maudling introduced his observations with a reference to more than 40 years of Fairey history during which there had been no diminution of the spirit of enterprise that had marked the company's foundation. He said that this was the second Fairey celebration he had attended: the other had been for the first "kill" [of a target aircraft] by a British guided weapon.

Mentioning that the F.D.2 was "one of Her Majesty's aircraft", Mr. Maudling congratulated the pilot and the teams concerned in the record. Russia and the United States, he continued, might have aircraft as fast as, or faster than, the F.D.2; but the question was, could they achieve the speed with the control required under record conditions? Adding that he believed the F.D.2 "still had a bit in hand", the Minister concluded by saying that the country must get the best out of the facilities it had, particularly its brains.

Replying, Sir Richard Fairey recorded his company's pleasure at the presence of the Duke of Edinburgh and thanked the Minister for his tributes. It would be false modesty, he said, to pretend that he was not proud and elated that the company he had founded 41 years ago had produced the first aircraft to surpass 1,000 m.p.h. under record conditions. It was the fourth time that Fairey aircraft had broken world records and, he added, it would not be the last. Such a record was, of course, a team effort, and Peter Twiss was a great pilot.

After referring to the F.D.2 as "A hurtling missile travelling at nearly 20 miles per minute at 38,000ft through a narrow ribbon of air," Sir Richard went on to congratulate Mr. Robert Lickley (the chief engineer, who directed the F.D.2 design effort) as "a great engineer" and Mr. Geoffrey Hall (assistant managing director, and the record-team captain) as the man who had provided the leadership and drive behind the effort. He also paid a tribute to Lord Hives, chairman of Rolls-Royce—who was present at the luncheon with several other members of his company—for the "one little engine" which had provided the power; the R.A.E. and the timekeepers who were responsible for the recording; and Fighter Command, who had vectored the flight. All these received from Sir Richard their share of the praise and credit, and finally he thanked the Ministry of Supply for their support and help—especially in having ordered the machine in the first place!

The luncheon concluded with the showing of a short but dramatic colour film, taken by the company, of the preparations and flights of the F.D.2 during the period of successful attempt on the record. Guests were particularly impressed by the rapid acceleration of the aircraft on take-off and the steep climb from the Boscombe Down runway. The contrail left by the machine on its runs, essential for tracking and camera observations, was seen with exceptional clarity. No tail parachute was found necessary on any of the landings.

Before his departure, the Duke of Edinburgh accepted from Sir Richard Fairey a handsome silver model of the F.D.2.

Air Race Entries

ENTRY lists for this year's National Air Races have been announced by the Royal Aero Club and are given below. As previously reported in *Flight*, the four class-races will each consist of three rounds. Two rounds of each race will be flown at the Whit Monday meeting at Yeadon, and the final rounds will be contested at Baginton on Saturday, July 21st.

Aircraft have been allocated to the respective races by the Royal Aero Club, and the first 15 British pilots in the British Air Racing Championship table will compete in the King's Cup race at the Baginton meeting. Most interesting newcomer to this season's racing is the long-awaited Somers-Kendall S.K.1, to be flown by Nat Somers, last year's air racing champion. The full list of pilots and aircraft is as follows:

S.B.A.C. Cup.—J. N. Somers (Somers-Kendall S.K.1), F. Dunkerley (Sparrowjet), R. R. Paine (Hawk Speed Six), S/L. J. Rush (Falcon Six), G. C. Marler (Falcon Six), A. S. K. Paine (Proctor 1), E. Crabtree (Proctor 3), W/C. R. H. McIntosh (Proctor 3).

Osram Cup.—P. Blamire (Gemini 1a), E. Crabtree (Gemini 3), T. G. Knox (Proctor 3), E. N. Husbands (Proctor 1), A. Barker (Proctor 3), J. N. Somers (Chipmunk), J. R. Johnston (Hawk Trainer 3), J. E. G. Appleyard (Chilton D.W.1a).

Kemsley Trophy.—A. J. Spiller (Messenger 2a), Miss A. Windle (Whitney Straight), W. P. Bowles (Monarch), J. H. Denyer (Tiger Moth), J. M. Donald (Tiger Moth), B. J. Snook (Tiger Moth), S/L. D. P. Boulnois (Tiger Moth), J. G. Lovegrove (Tiger Moth).

Goodyear Trophy.—C. Gregory (Taylorcraft Plus D), M. J. Marshall (Tiger Moth), W. H. Bailey (Moth Minor Coupe), D. F. Ogilvy (Comper Swift), Hon. P. Vanneck (Tiger Moth), N. D. Norman (Tiger Moth), F/O. A. G. Oldham (Tiger Moth), N. H. Jones (Tiger Moth). *Reserves:* C. G. Wheatley (Globe Swift), H. B. Iles (Miles M. 18/2).

Swansea Rally

A VERY successful Franco-British week in Swansea concluded last Friday evening with an "air ball" in the Brangwyn Hall, followed on Saturday by a flying rally. Both functions were attended by French private pilots, including M. and Mme. Kilian Hennessy of Cognac fame, who arrived in a Macchi 320; M. Mouza, Mme Dormois and M. Cornu, who came from Joigny in two Minicabs; and M. Le Fage in a Piper Pacer.

Held at Fairwood Common airfield, the rally was opened by the mayor of Swansea, Councillor P. Morris, who announced that the airfield was finally to be developed as Swansea's civil airport by Cambrian Airways, Ltd., who have approval for a service between Haverfordwest, Swansea, Cardiff and London.

Flying included an arrival competition, won by Mr. F. Griffiths in an Auster, and a spot-landing contest, won by Mr. J. S. Eynon of Swansea in the Mosscraft. The *concours d'élégance* was won by M. Le Fage with the Pacer. Two Auster 6s of No. 663 A.O.P. Sqn., R.Aux.A.F., contributed enterprisingly to a windy but cheerful afternoon's sport.

"Flight" photograph

The scene at London Airport on April 25th—Tu-104s L5400, L5412 and L5413 during a lull in their task of ferrying good cheer and good will between London and Moscow during the Soviet leaders' visit to England.

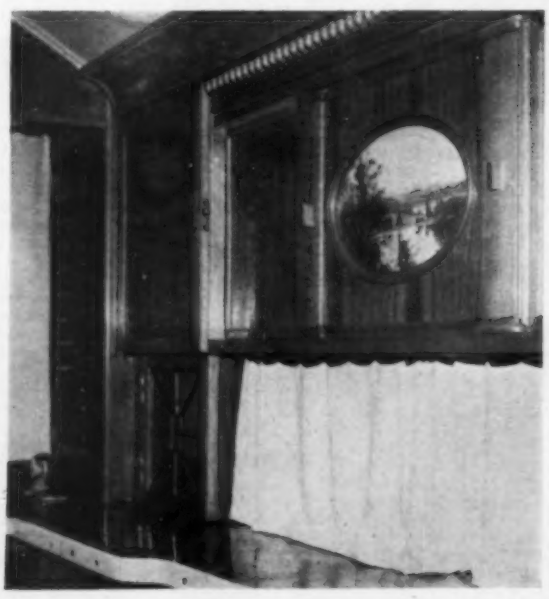
CAVIARE SPECIAL

WE have already published an account and our artist's impressions of the Tu-104's cabin (in our issues of April 6th and 13th), but here for the first time are photographs of this remarkable airliner-interior. The aircraft depicted is furnished to an exceptional degree of luxury, and its ornamentation—too fussy for Western V.I.P. tastes—is probably not typical of the workaday Aeroflot airliners.

The effect is one of spaciousness and high-quality workmanship. Beautifully carpentered and polished wooden panelling is abundant, especially in the lounge-bar. Walls and seats are in a medium grey, the ceiling beige and the carpet forest-green. All metal fittings are of "glittering gold"—probably specially anodised light alloy.

Entering the aircraft on the port side—significantly, previous Russian airliners have had the entrance door on the starboard side—the passenger steps into a vestibule with lockers and cupboards for baggage and coats; leading off from this section to aft are the washrooms and lavatories. The main cabin has 28 seats, each with an oxygen spray attached. Luggage racks

(Below) Porcelain figurines in thick plastic glass showcases no doubt advertise the smoothness of the Tu-104 travel. (Right) Not the view from the window, but a hand-painted mural in the bar-lounge.



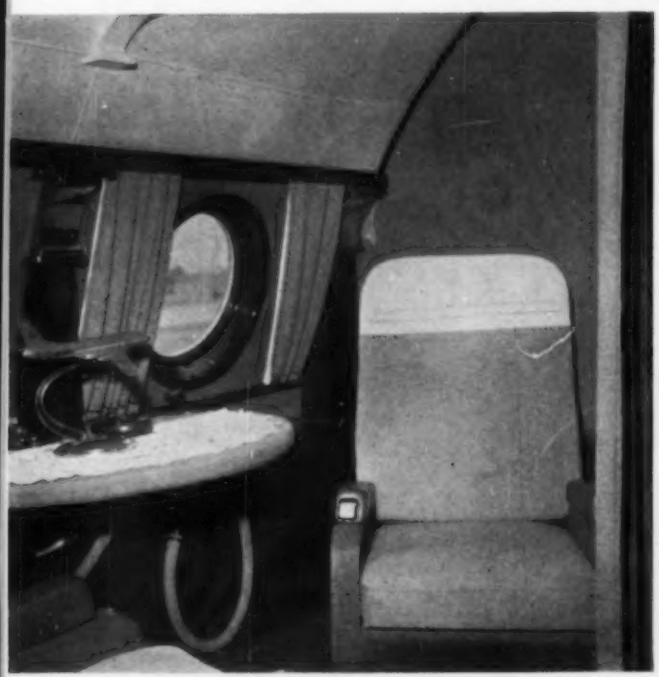
(Left) Capt. Victor Ivanov at the controls; instrumentation is simple (see text). Note the navigator's position beyond the curtain. The control pedestal is not visible. (Above) The view aft from the eight-seat compartment, showing the rococo styling and heavy ornamentation.

are of the railway coach net type, and the overhead light fittings are reminiscent of the décor of the 1920s. Seats are adjustable, although not fully reclining, and at about 40in pitch—about the usual Western first-class spacing.

There are three first-class compartments or lounges, one with eight seats, the forward two with four seats and a bar apiece, making up seating accommodation to 50 in all.

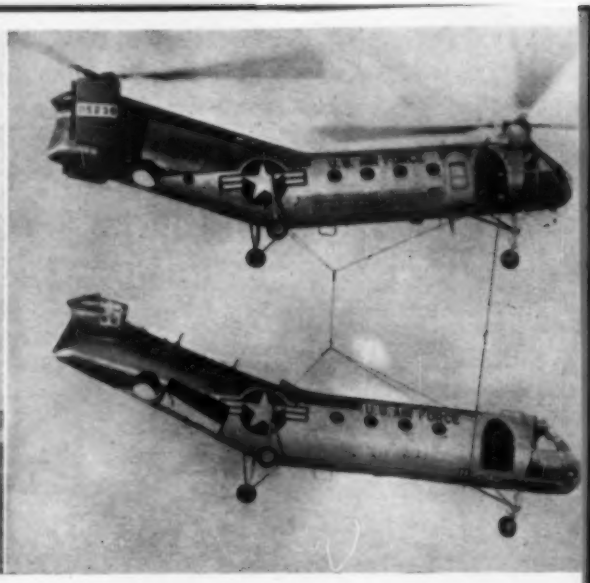
The flight deck accommodates two pilots, a navigator (in the nose), an engineer and a radio officer. The instrument panels and controls appear to be neat and simple.

Visible in the cockpit is a range of well-disposed equipment. In front of the pilot are two A.D.F.-type dials and a remote indicating compass, gyro D.I., I.L.S. meter and sensitive altimeter or two-needle A.S.I. Engine instruments are located on the central panel, together with a three-light undercarriage indicator. The ceiling panel carries numbers of switches and warning lights, particularly seven connected with the fuel tankage. An electric fan and dark eye-shade help the pilot. Most interesting feature is the adjustable right arm-rest supporting the arm working a stick-top autopilot controller similar to advanced American models. This arm-rest is massively mounted and can be swung right up out of the way.



(Right) A corner of the lounge-bar, showing the aircraft seating diagram. (Left) A whiff of oxygen—supply tubes can be seen beneath the table—is at hand for every passenger. (Below) More lace.

HERE AND THERE



***STRONG - ARM STUFF:** Towing a 300-ton salvage derrick to prove helicopter advantages for mine-sweeping is a Bell HSL-1. Playing Good Samaritan to a damaged machine of its own kind is a Vertol H-21.*

More B-52s

AN additional order for 80 Boeing B-52 bombers has been placed by the U.S. Government. The aircraft will cost $230m (about £82m). Accelerated production will be ordered immediately if Congress grants the additional funds asked for by President Eisenhower.

York Trooping Ban

PENDING inquiries, York aircraft are not to be used for trooping. This Air Ministry decision followed a take-off accident to a Scottish Airlines York at Stansted last Monday, in which two passengers, an airman and a child, lost their lives and four were injured. Fortunately, there was no fire, and the remainder of the 54 occupants escaped uninjured. This was the fourth trooping accident involving a York since February, 1953, and earlier this year questions were asked in Parliament.

Merlins for Spain

THE Hillington, Glasgow, works of Rolls-Royce, Ltd., is not entirely occupied with jet engine work: it is also busy on a £1m contract for Merlin engines for the Spanish Government. Over 170 engines are now in production; the first part of the order, which included spares and tools, has already been shipped. The Merlins are for the C.A.S.A. 2.111 (the Spanish-built version of the He111) and Hispano HA.1109 (the Spanish Me109).

Useful Reading-matter

OPERATORS of motor transport fleets may like to note that in today's (May 4th) issue of *Motor Transport* is a set of "Revised Cost Tables." These give, in great detail, the various items that make up the cost of operating fleets of various sizes, and fluctuating figures have been brought thoroughly up to date. Other special features of Iliffe journals at this time include the Ciné Buyers Guide Number of *Amateur Photographer* next Wednesday, May 9th; and the Exhibition Preview Number, appearing early next week, of *Mechanical Handling*. The latter constitutes a detailed guide to the Mechanical Handling Exhibition and Convention, which opens at Earls Court on May 9th.

***HISTORIC MENU** from the Fairey celebration luncheon reported on page 519. The signatures are those of Sir Richard Fairey (top) and Messrs. Robert Lickley, Peter Twiss and Geoffrey Hall.*

A Talk by "H.P."

ON Thursday next, May 10th, Sir Frederick Handley Page is to lecture to the Graduates' and Students' Section of the Royal Aeronautical Society on *Some Thoughts on Present-day Aircraft and the Future*. The talk was originally to have been given on May 1st.

Whirlwind for Saudi Arabia

AMONG the duties of a Westland Whirlwind helicopter recently ordered by Saudi Arabia is likely to be the transportation of the King on hunting trips. The contract was signed by Saudi Arabian Airlines, who will operate the helicopter on behalf of the Government.

THE WORLD'S ENGINES

NEXT Friday, May 11th, the special "Aero Engines of the World" number of *Flight* will appear. Contents will include an appraisal of design-trends in the supersonic turbojet, and a very fully illustrated review of the notable power units of all engine-manufacturing countries.

Treat out of Store

AS part of the celebration of the firm's centenary, more than 100 employees of Marshall and Snelgrove (Adderly and Co., Ltd.), Leicester, will have pleasure flights round the city in a Rapide on May 10th. They will also see an air display specially arranged for them. The Rapide will be flown by Mr. A. E. Bramson, assistant to the managing director; he holds a Commercial Pilot's Licence.

Helicopter History on Film

THE film to be shown to members of the Helicopter Association next Friday, May 11th, will be *The Story of the Helicopter*, made by Capt. R. N. Liptrot for the Ministry of Supply. Non-members of the Association are invited to the performance, which takes place at 6 p.m. in the library of the Royal Aeronautical Society, 4 Hamilton Place, London, W.1. The Helicopter Association, incidentally, has announced that Lord Brabazon has accepted an invitation to become its president for 1956-57.

***DUAL COUGAR:** Over a hundred of these Grumman F9F-8T Cougars are being built for the U.S. Navy. The type will be used as an operational fighter as well as a jet trainer, and is armed with two 20 mm guns and external stores.*

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MEMBER OF THE OWEN ORGANISATION

Aerodynamic Aspects of Helicopter Design

Lecture to the Helicopter Association

IN a highly technical and specialized paper, presented to a recent meeting of the Helicopter Association of Great Britain, Dr. H. Roberts, Ph.D., discussed some of the lesser-known aspects of the work of a helicopter design team. He said that until recently all the efforts of the aerodynamicists had of necessity been directed towards improving performance characteristics, since these were so marginal in early helicopters. Today, the industrial aerodynamicists' tasks covered a much wider field comprising: (1) Prediction and analysis (including performance analysis, stability and control characteristics); (2) wind-tunnel and spinning-rig testing; and (3) flight testing and analysis. In addition, the provision of stressing data was an important feature. Much of the work of the aerodynamics office was concerned with establishing techniques, since no existing methods could be applied as in the case of aeroplanes.

Dr. Roberts described at length the various methods for determining performance characteristics, examining some of their merits and demerits, and then continued with a discussion of stability and control. The problem was more complex than the equivalent fixed-wing problem because in the helicopter (assuming the use of articulated blades) the fuselage and rotor interacted one upon the other. The effect could best be explained by means of a simple diagram. (Fig. 1) Any outside disturbance affected both the rotor and the fuselage together but, in addition, a change in fuselage attitude affected the rotor through a "feed back" and this, in turn, further affected the fuselage. The observed motion as a result of the original disturbance was the total of these effects.

The influence of the pitching moments of the fuselage on static stability was unusual, particularly in respect of short fuselages. Over the normal working range of incidence they tended to be unstable, but at the larger positive and negative angles there was a

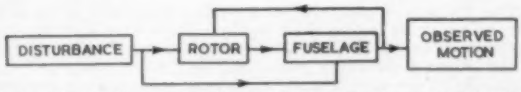

Fig. 1. Simple diagram showing the interaction of rotor and fuselage in the disturbance case.

region of stability. The addition of a tailplane provided some measure of stability in forward flight but the effect was not entirely as might be expected. Over the working incidence range, the combination of fuselage and tailplane was stable. At large positive and negative fuselage angles, however, the question of tailplane stall had to be taken into account and, whereas the fuselage by itself might be stable at these angles, the combination was unstable.

Although a helicopter might be statically stable, a divergence might arise when control movements were applied. Methods of improving stability included the fixed tailplane, the use of offset hinges in the rotor head and variations in c.g. position. The first was very effective in increasing damping in the fore and aft sense although it did introduce other problems. Offset hinges also increased damping to a certain extent; but their efficacy was questionable for other than the improvement of static stability, since it had been shown by calculation that the damping effect might be reduced to quite low values at some speeds as they were moved outward from the rotor axis. The effect of c.g. movement was similar to aeroplane experience, stability characteristics deteriorating as the c.g. was moved aft. The provision of desirable handling qualities in roll and yaw could be achieved by having a low rotor speed in both cases, but this requirement had to be related to other considerations.

The lecturer went on to say that the lack of systematic flight records of the normal accelerations to which helicopters were subject made stressing requirements rather a matter for synthesis of response and possible flight loading conditions rather than a matter of experience. Normal accelerations could be induced in two ways, either by the application of cyclic pitch or collective-pitch. The application of the former gave a small immediate increase in g, followed by a steady build up to a maximum in a few seconds. The amount of g per degree of cyclic-pitch applied decreased with speed, and at low speed this was an inefficient method of producing normal accelerations. On the other hand collective-pitch application gave a nearly instantaneous increase in g and was most effective at low speeds. The maximum g in this case was determined either by the maximum collective-pitch angle available or by the stalling lift coefficient of the blades.

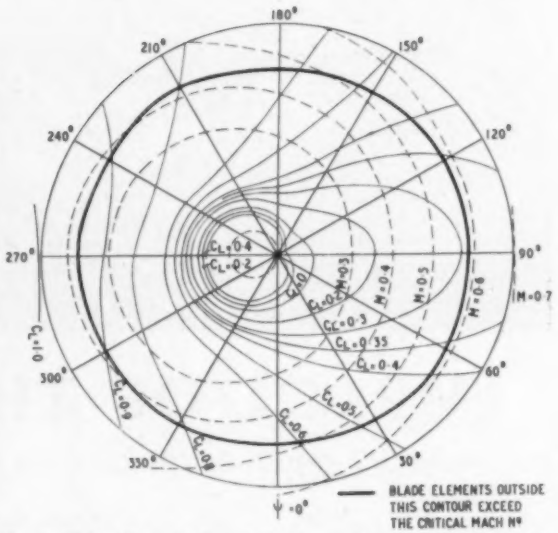

Fig. 2. Distribution of lift coefficient over the rotor disc where the tip speed is 650 ft/sec and the tip speed ratio is 0.2. The broken-line contours indicate Mach number and blade elements outside the heavy contour exceed the critical Mach number. Direction of rotation is anti-clockwise.

The effect of gusts was not of primary importance on modern helicopter rotors. As speeds increased, the effects of gusts on winged helicopters were, on the other hand, quite serious because the wing lift increment at constant vertical gust velocity increased linearly with forward speed. This characteristic was quite different from the normal rotor one in which g was substantially constant, independent of speed (apart from the effect at very low speeds). As was to be expected, the effective low aspect-ratio of a rotor gave low values of lift variation with incidence and this effect, apart from the change in form of variation with speed, tended to give low gust load factors.

Outstanding problems concerned mainly the need for more data on a number of subjects, including the following: (1) Blade and fuselage drag; (2) induced velocity—including the interference effects between multiple rotors; (3) blade stall and critical Mach numbers, including the effect of vibration levels on the acceptable degree of permissible stalling; (4) desired handling characteristics and autostabilization; (5) stability derivatives and the correlation of wind-tunnel and full-scale results on these.

Other items which required the devotion of much effort were: (6) The collection and collation of data on flight and gust envelopes; (7) a more accurate analysis of the off-loading wing as an aid to the attainment of higher speeds; (8) specialized wind-tunnel problems, such as scale effects and tunnel constraint effects; (9) the investigation of special devices (e.g., the jet flap).

Dr. Roberts concluded by saying that the true function of the aerodynamics office was not entirely that of performance estimation, which should be an automatic process dependent upon standardized text-book procedures. Far greater effort should be concentrated on aerodynamic handling aspects, and the aerodynamicist had an important part to play in improving the "breed" to a stage where a few successful British types could be produced. This might do much to halt the present trend away from helicopters and towards other forms of low-speed aeroplanes.

SECOND SUPER-CARRIER

THE U.S.S. *Saratoga*, second of the U.S. Navy's super-carriers, was commissioned in the New York Naval Yard recently. There were 6,000 guests at the ceremony. *Saratoga* cost £74m and is three feet longer than *Forrestal*, the first of the class, which is already in service. *Saratoga's* engines, more powerful than those of her sister ship, develop 250,000 h.p., giving her an "average speed" of 34 kt. She can accommodate 100 aircraft. Carriers of the same class now building or projected are the CVA-61 *Ranger* and the still-unnamed CVA-62.

IMPACT OF THE HEAVY JETS

How the World's Airports Will Match Up to the DC-8 and the Boeing 707: a Flight *Analysis*

By J. M. RAMSDEN

"BEFORE we start pitching we must first establish the size of the ballpark." A neat summary by Charles J. Lowen, administrator of the U.S. Civil Aeronautics Administration, of the problem very much in everyone's mind: the airport requirements of the DC-8 and the Boeing 707. Mr. Lowen might also have mentioned the strength of the ballpark, since the two players concerned are pretty hefty specimens.

There has been much gloomy headshaking on this subject, and allegations that the world's airlines—which do not directly have to foot the bill for the improvement of airports—are irresponsibly buying airliners that will be hopeless runway misfits. It is, say the critics, difficult enough for national airlines which have ordered these aircraft to persuade their own governments (or municipal authorities, as the case may be) to spend the necessary sums of taxpayers' money on new runways: but will other countries, through which the aircraft will operate, be easily persuaded?

The answer is, of course, that nations will have to "keep up with the Joneses" in the matter of airports, just as the airlines are doing in the buying of aircraft. It is more than a matter of keeping up with the Joneses—the world wants and needs airliners of the calibre of the DC-8 and Boeing 707. In the U.S.A., as might be expected, practical steps have been taken (to the tune of £15 million) for the improvement of airports, which already are among the best in the world, although even this is regarded only as an immediate interim measure. Chicago alone wants very nearly that amount spent on it eventually.

It would be stupid to assume that Boeing and Douglas and their experienced customers are deluding themselves about the impact—literally—of their new airliners upon the world's runways. All of the countries whose national airlines have ordered the aircraft are already urgently reviewing their airports, and some, e.g., Sweden and Switzerland, have already put big improvement programmes in hand.

The object of this analysis, therefore, is not to show that the DC-8 and 707 are hopeless runway misfits, but to indicate just how much airport work has got to be done before their full value can be exploited. Exactly what, then, is involved?

A detailed assessment of 58 of the world's main airport runways in the light of published data on the DC-8 and 707 shows that at present only one, Casablanca (Nouasseur), is capable of taking the aircraft at full load with 100 per cent regularity—i.e., on every day of the year. Leopoldville and Stockholm will, when present improvements are finished, also be adequate. Of the rest, 25 are deficient both in length and in strength, and 30 are lacking in one respect or the other. A similar analysis of the runways of 80 diversion airports (which include some of the main airports) shows that 30 per cent also fall below requirements, even at the lighter landing loads considered. These are startling conclusions, and the assumptions made in arriving at them need stating carefully.

The 58 main airports chosen are those which are likely to be used as terminals for full-load flights. They were selected from the route-networks of the 17 airlines which have so far ordered either DC-8s or 707s (see tables), and they will actually be found to include all the world's major trunk terminals—a sharp reminder of the way in which these aircraft are going to dominate world traffic in five years' time. These main airports will not, of course, always be used for full-load take-offs; but it is fair to examine them all on this assumption if the full intercontinental potentialities of the DC-8 and the 707 are to be realized.

The accompanying tables include, firstly, the paved length of the longest runway of each airport, as it stands at present. Where extensions are being made, the proposed future length, if known, has been assumed (it is marked with an asterisk). The actual length of any runway is, of course, no guide to its suitability unless local elevation and temperature—the average daily temperature for the hottest month of the year—are known, and it is necessary to apply correction factors where these exceed standard conditions—i.e., sea level and 15 deg C (at sea level) respectively. Slope has been discounted throughout. The correction factors used in this study are those recommended by I.C.A.O. (*International Standards and Recommended Practices*, Annex 14). For elevation, the correction is 7 per cent per 300m (1,000ft) above mean sea level. This corrected length is further adjusted at the rate of 1 per cent for every 1 deg C that the airfield reference temperature exceeds standard atmosphere temperature *at that elevation*. Statistical deviation from average has been ignored. Some authorities—e.g., the United States C.A.A.—recommend that the temperature correction should be at the rate of ½ per cent for every 1 deg *Fahrenheit* above standard: this correction is slightly less severe than the other, but it is generally agreed that for pure-jet aircraft, the performance of which is markedly sensitive to temperature, a rather more severe correction than either may be required. Published Douglas figures show that DC-8 take-off distances are substantially greater in I.S.A.-plus conditions than the I.C.A.O. correction method indicates; and although it is generally recognized that the I.C.A.O. method is in need of revision, it has been used in this study even though

KEY TO ABBREVIATIONS IN TABLES OPPOSITE AND ON p.526

iswl, isolated single wheel load; auw, all-up, or gross, weight; * projected figure. (1) (in heading, last col.), a dash signifies suitability. (2) 2,316ft tarmac, the rest laterite. (3) For 7,337ft only. Runway 19 has 4,428ft capable of taking 59,524 lb iswl. (4) Strengthening to this amount is at present being carried out. (5) At 70 lb/sq in tyre pressure. (6) This is the weight of the largest aircraft accepted, the Globemaster. (7) This is the weight of the DC-6B, usually largest type accepted. (8) It is believed that B-36s can be accepted (300,000 lb). (9) May be finished in 1956. (10) Normally restricted to 110,000 lb auw. (11) Very limited facilities. (12) Restricted to aircraft of 10,000 lb auw. (13) May be too far. (14) New 10,000ft runway has just been started. (15) Four-wheel bogie. (16) Pietersburg and Kimberley have earth runways only. (17) Despite this figure Qantas operate Super Constellations into Karachi. (18) 7,870ft by day. (19) Landing only.

N.B.—Data in the first four columns of each table have been compiled with the help of the Aeronautical Information Service of the Ministry of Transport and Civil Aviation and are accurate to the best of their belief.

AIRPORTS OF THE WORLD

Their Suitability for the Douglas DC-8 and Boeing 707: for Assumptions see Article

Airport and Alternates	Length Main Runway ft	Strength Main Runway lb	Elev. ft	Temp. Deg C	Approx. Length Required ft	Suitability(1)	
						Length ft (approx.)	Strength
Algiers (Maison Blanche)	7,972	99,210 iswl	82	29.4	10,400	−2,430	—
Valencia (200 miles)	7,787	51,180 iswl	213	30.7		—	—
Barcelona (280 miles)	7,874	147,710 iswl	13	28.0		—	—
Amsterdam (Schiphol)	8,364	148,800 iswl	−13	20.8	9,500	−1,140	—
Dusseldorf (110 miles)	8,120	75,000 iswl	122	23.5		—	—
London (230 miles)	9,570	L.C.N. 100	80	22.0		—	—
Auckland (Whenuapai)	6,590	51,000 iswl	100	22.6	9,700	−3,110	Weak
Ohakea (240 miles)	7,000	51,000 iswl	175	21.0?		—	—
Christchurch (Harewood) (480 miles)	6,600	51,000 iswl	113	21.0		—	—
Bangkok (Don Muang)	8,528	132,280 auw (wet)	12	35.0	10,800	−2,270	Weak
Rangoon (Mingaladon) (360 miles)	8,100	150,000 auw	100	35.2		—	—
Beirut	7,800	300,000 auw (app.)	86	33.0	10,600	−2,800	—
Cairo (350 miles)	9,354	400,000 auw	311	41.0		—	—
Nicosia (160 miles)	5,930	L.C.N. 45	728	40.0		Marginal	—
Bermuda (Kindley)	8,843	250,000 auw	11	29.0	10,200	−1,350	—
New York International (760 miles)	9,422	260,000 auw	12	28.0		—	—
Bombay (Santa Cruz)	7,050	60,000 iswl	27	30.9	10,400	−3,350	Marginal
Ahmedabad (280 miles)	6,000	60,000 auw	180	41.0		—	Weak
Brazzaville (Maya Maya)	7,546	297,621 auw	1,043	31.6	11,500	−3,950	—
Pt. Noire (230 miles)	6,266	44,000 iswl[2]	49	27.0		—	—
Brussels (National)	8,050	143,300 auw	158	22.8	9,850	−1,800	Weak
Amsterdam (100 miles)	8,364	148,800 iswl	−13	20.8		—	—
Paris (Orly) (180 miles)	7,874	99,210 iswl	295	25.2		—	—
Buenos Aires (Moron)	11,810	26,455 iswl[3]	82	29.2	10,400	—	Weak
Montevideo (Carrasco) (150 miles)	7,052	70,547 iswl[4]	75	28.0		—	—
Cairo	9,354	400,000 auw	311	41.0	11,600	−2,250	—
Nicosia (360 miles)	5,930	L.C.N. 45	728	40.0		Marginal	—
Beirut (350 miles)	7,800	300,000 auw (app.)	86	33.0		—	—
Calcutta (Dum Dum)	7,000	175,000 auw (app.)	14	34.3	10,700	−3,700	Marginal
Gaya (270 miles)	6,000	60,000 auw[5]	370	42.0		—	Weak
Chittagong (220 miles)	6,000	175,000 auw[6]	12	36.0?		—	—
Caracas (Maiquetia)	7,200	100,000 auw[7]	153	33.9	10,800	−3,600	Weak
Port of Spain (Piarco) (380 miles)	7,810	200,000 auw	37	30.5		—	—
Casablanca (Nouasseur)	11,000	300,000 auw[8]	656	23.0	10,300	—	—
Meknes (130 miles)	8,200	44,090 iswl	1,889	22.0?		—	—
Seville (290 miles)	7,053	124,340 iswl	98	35.5		—	—
Chicago (O'Hare)	8,100[9]	60,000 iswl	657	26.4	10,650	−2,500	Marginal
Detroit (Wayne Major) (220 miles)	7,900	250,000 auw	639	25.0?		—	—
St. Louis (Lambert) (250 miles)	10,015	200,000 auw	558	25.0?		—	—
Cologne	8,000	65,000 iswl	267	25.5		−2,200	—
Dusseldorf (30 miles)	8,120	75,000 iswl	122	23.5	10,200	—	—
Frankfurt (90 miles)	7,000	100,000 iswl	368	26.6		—	—
Colombo (Ratmalana)	6,013	30,000 iswl[10]	22	30.7	10,450	−4,440	Weak
Jaffna (Kankesantwai) (210 miles)	7,500	as above	33	30.0?		—	Weak
Copenhagen (Kastrup)	7,558	220,000 auw	16	21.0	9,550	−2,000	—
Stockholm (Jordbro) (320 miles)	10,800*	n/a	46	27.0		—	—
Oslo (300 miles)	8,200	99,100 auw	665	21.3		—	—
Dakar (Yof)	7,897	44,000 iswl	75	29.4	10,400	−2,500	Weak
Thies (40 miles)	5,905	28,600 iswl	269	27.0?		Marginal	Weak
Sal (390 miles)	6,561	99,180 auw	184	28.0?		—	Weak
Dusseldorf	8,120	75,000 iswl	122	23.5	9,850	−1,730	—
Amsterdam (110 miles)	8,364	148,800 iswl	−13	20.8		—	—
Brussels (100 miles)	8,050	143,300 auw	158	22.8		—	—
Entebbe	9,900	135,000 auw	3,750	25.7	13,300	−3,400	Weak
Nairobi (Eastleigh) (320 miles)	7,980	100,000 auw	5,371	25.7		—	Weak
Kisumu (160 miles)[11]	6,000	80,000 auw	3,795	34.0		—	Weak
Fiji (Nandi)	7,144	52,000 iswl	61	33.0	10,650	−3,500	Weak
Fiji (Nausori) (80 miles)	7,000	4,500 iswl[12]	19	33.0		—	Weak
Tutuila I. (Tafuna)[13] (820 miles)	6,080[14]	80,000 auw	6	30.0?		—	Weak
Frankfurt	7,000	100,000 iswl	368	26.6	10,400	−3,400	—
Dusseldorf (30 miles)	8,120	75,000 iswl	122	23.5		—	—
Bale (Mulhouse) (175 miles)	7,775	99,000 iswl	833	24.0?		—	—
Geneva (Cointrin)	10,428*	77,100 iswl	1,600	33.3	12,150	−1,720	—
Paris (Orly) (245 miles)	7,874	99,210 iswl	295	25.2		—	—
Frankfurt (285 miles)	7,000	100,000 iswl	368	26.6		—	—
Hong Kong	7,200*	n/a*	12	29.0	10,300	−3,100	O.K.?
Manila (700 miles)	7,500	200,000 auw	67	33.4		—	—
Taipei (505 miles)	7,600	33,000 iswl	70	35.0		—	Weak
Honolulu (International)	13,104	200,000 auw[15]	10	29.5	10,300	—	Weak
Hilo (200 miles)	6,500	150,000 auw	31	30.0?		—	—
Johannesburg (Jan Smuts)	10,500	135,000 iswl	5,559	23.3	14,800	−4,300	—
Waterkloof (Pretoria)[16] (35 miles)	8,400	100,000 iswl	4,941	23.0?		—	Marginal
Karachi	7,500	102,000 auw[17]	83	34.0	10,700	−3,200	Weak
Nawabsham (120 miles)	6,000	160,000 auw	120	34.0?		—	—

★ For key to numbered references see footnote opposite

[CONTD. OVERLEAF

AIRPORTS OF THE WORLD (contd.)

Key to references—p.524

Airport and Alternates	Length Main Runway ft	Strength Main Runway lb	Elev. ft	Temp. Deg. C.	Approx. Length Required ft	Suitability(1)	
						Length ft (approx.)	Strength
Leopoldville	15,400*	n/a*	971	30.3	11,200	—	O.K.?
Pt. Noire (240 miles)	6,266	44,000 iswl[2]	49	27.0		—	—
Lima ('Tambo)	12,000*	175,000 auw[6]	483	26.8	10,400	—	Marginal
Pisco (125 miles)	12,000*	44,090 iswl	19	27.5		—	—
Lisbon	6,823	77,160 iswl	360	22.6	10,000	−3,180	—
Madrid (320 miles)	10,006	141,090 iswl	1,984	33.2		—	—
Seville (200 miles)	7,053	124,340 iswl	98	35.5		—	—
London	9,570	L.C.N. 100 (10R/28L)	80	22.0	9,700	Marginal	—
Prestwick (325 miles)	7,000	L.C.N. 60	63	19.0		—	—
Shannon (370 miles)	7,024	140,000 auw	15	18.1		—	—
Los Angeles	8,561	200,000 auw	125	20.0	9,550	−1,000	—
Fresno (200 miles)	7,028	n/a	331	20.0?		—	—
San Diego (Lindbergh) (125 miles)	8,100	260,000 auw	15	20.0?		—	—
Manila	7,500	200,000 auw	67	33.4	10,600	−3,100	—
Hong Kong (702 miles)	7,200*	n/a*	12	29.0		—	O.K.?
Clark (U.S.A.F.) (55 miles)	8,500	70,000 iswl	475	28.0?		—	—
Mexico City (Central)	9,930	100,000 auw	7,347	24.5	16,700	−6,770	Weak
Acapulco (170 miles)	7,500	80,000 auw	6	30.0?		—	Weak
Miami (International)	9,400	200,000 auw	9	30.3	10,400	−1,000	—
Tampa (205 miles)	6,998	120,000 auw	26	30.0?		—	—
Montevideo (Carrasco)	7,052	70,547 iswl[4]	75	28.0	10,200	−3,150	—
Buenos Aires (Moron) (150 miles)	11,810	26,455 iswl[3]	82	29.2		—	Weak
Montreal (Dorval)	7,000	145,000 auw	104	22.0	9,750	−2,750	Weak
Toronto (Malton) (315 miles)	6,200	n/a	565	20.0?		—	O.K.?
Nairobi (Eastleigh)	7,980	100,000 auw	5,371	25.7	14,850	−6,870	Weak
Entebbe (320 miles)	9,900	135,000 auw	3,750	25.7		—	—
Dar-es-Salaam (420 miles)	8,000	70,000 iswl	181	29.4		—	—
New York (International)	9,422	260,000 auw	12	28.0	10,200	−780	—
Washington (215 miles)	6,740	120,000 auw	16	29.7		—	—
Boston (Logan) (185 miles)	10,012	200,000 auw	19	25.5		—	—
Oslo	8,200	99,100 iswl	665	21.3	10,100	−1,900	—
Copenhagen (300 miles)	7,558	220,000 auw	16	21.0		—	—
Stockholm (260 miles)	10,800*	n/a*	46	27.0		—	O.K.?
Panama (Tocumen)	7,000	145,000 auw	150	34.0	10,800	−3,800	Weak
Barranquilla (Soledad) (340 miles)	5,180	100,000 auw	44	34.0?		−820	Weak
Medellin (Olaya Herrera) (325 miles)	8,202	120,000 auw	4,650	28.0?		—	—
Paris (Orly)	7,874	99,210 iswl	295	25.2	10,300	−2,430	—
Brussels (175 miles)	8,050	143,300 auw	158	22.8		—	—
Toulouse (Blagnac) (375 miles)	8,202	220,500 auw	499	23.0		—	—
Rio de Janeiro (Galeao)	7,440	145,000 auw	10	27.8	10,100	−2,660	Weak
Sao Paulo (Congonhas) (225 miles)	6,119	120,000 auw	2,608	28.5		—	—
Rome	7,413	88,180 iswl	426	27.9	10,550	−3,140	—
Turin (340 miles)	7,709	77,160 iswl	981	28.0?		—	—
Naples (Capodichino) (110 miles)	7,217	61,730 iswl	289	27.8		—	—
Saigon (Tan Son Nhut)	7,053[18]	88,000 auw	33	29.0	10,300	−3,250	Weak
Bangkok (465 miles)	9,840[19]	132,280 auw (wet)	12	35.0		—	—
Pochentong (135 miles)	5,280	66,140 auw (wet)	33	30.0?		−720	Weak
San Francisco	8,870	125,000 auw	11	19.2	9,400	−530	Weak
Fresno (160 miles)	7,028	n/a	331	20.0?		—	O.K.?
Los Angeles (325 miles)	8,561	200,000 auw	125	20.0		—	—
Santiago (Los Cerrilos)	6,560	175,000 auw[6]	1,678	28.6	11,650	−5,090	Marginal
Mendoza (El Plumerillo (120 miles)	6,606	35,273 iswl	2,309	25.0?		—	Weak
Sao Paulo (Congonhas)	6,119	120,000 auw	2,608	28.5	12,600	−6,480	Weak
Rio de Janeiro (225 miles)	7,440	145,000 auw	10	27.8		—	—
Seattle	8,500	120,000 auw	416	20.0?	10,200	−1,700	Weak
Vancouver (120 miles)	8,600	75,000 iswl	9	20.0?		—	—
Singapore (Paya Lebar)	8,000	60,000 iswl	59	29.4	10,400	−2,400	Marginal
Kuala Lumpur (200 miles)	6,000	55,000 iswl	106	34.9		—	—
Butterworth (375 miles)	5,800	L.C.N. 35	8	30.8		Marginal	—
Stockholm (Jordbro)	10,800*	n/a*	46	27.0	10,100	—	O.K.?
Oslo (260 miles)	8,200	99,100 iswl	665	21.3		—	—
Copenhagen (325 miles)	7,558	220,000 auw	16	21.0		—	—
Sydney	7,898	100,000 iswl	10	24.5	9,900	−2,000	—
Williamstown (Newcastle) (100 miles)	8,000	75,000 iswl	23	24.0?		—	—
Dubbo (190 miles)	6,000	30,000 iswl	921	26.0		—	Weak
Tokyo	8,400	145,000 auw	2	27.7	10,200	−1,800	Weak
Osaka (Itami) (250 miles)	6,000	80,000 auw	39	35.0		—	Weak
Misawa (460 miles)	8,500	80,000 auw	118	27.0		—	Weak
Toronto (Malton)	6,200	n/a	565	20.0?	9,850	−3,650	O.K.?
Montreal (Dorval) (315 miles)	7,000	145,000 auw	104	22.0		—	—
Vancouver	8,600	75,000 iswl	9	20.0?	9,850	−1,250	—
Calgary (425 miles)	6,200	100,000 auw	3,557	20.0?		—	Weak
Seattle (120 miles)	8,500	120,000 auw	416	20.0?		—	—
Winnipeg	6,400	40,000 iswl	781	18.0?	9,900	−3,500	Weak
Rivers (145 miles)	6,000	100,000 auw	1,550	17.0?		—	Weak
Lakehead (325 miles)	6,200	80,000 auw	653	17.0?		—	Weak
Zurich (Kloten)	8,531	145,000 iswl	1,420	23.0	11,000	−2,470	—
Paris (Orly) (300 miles)	7,874	99,210 iswl	295	25.2		—	—
Geneva (Cointrin) (145 miles)	10,428*	77,100 iswl	1,600	33.3		—	—

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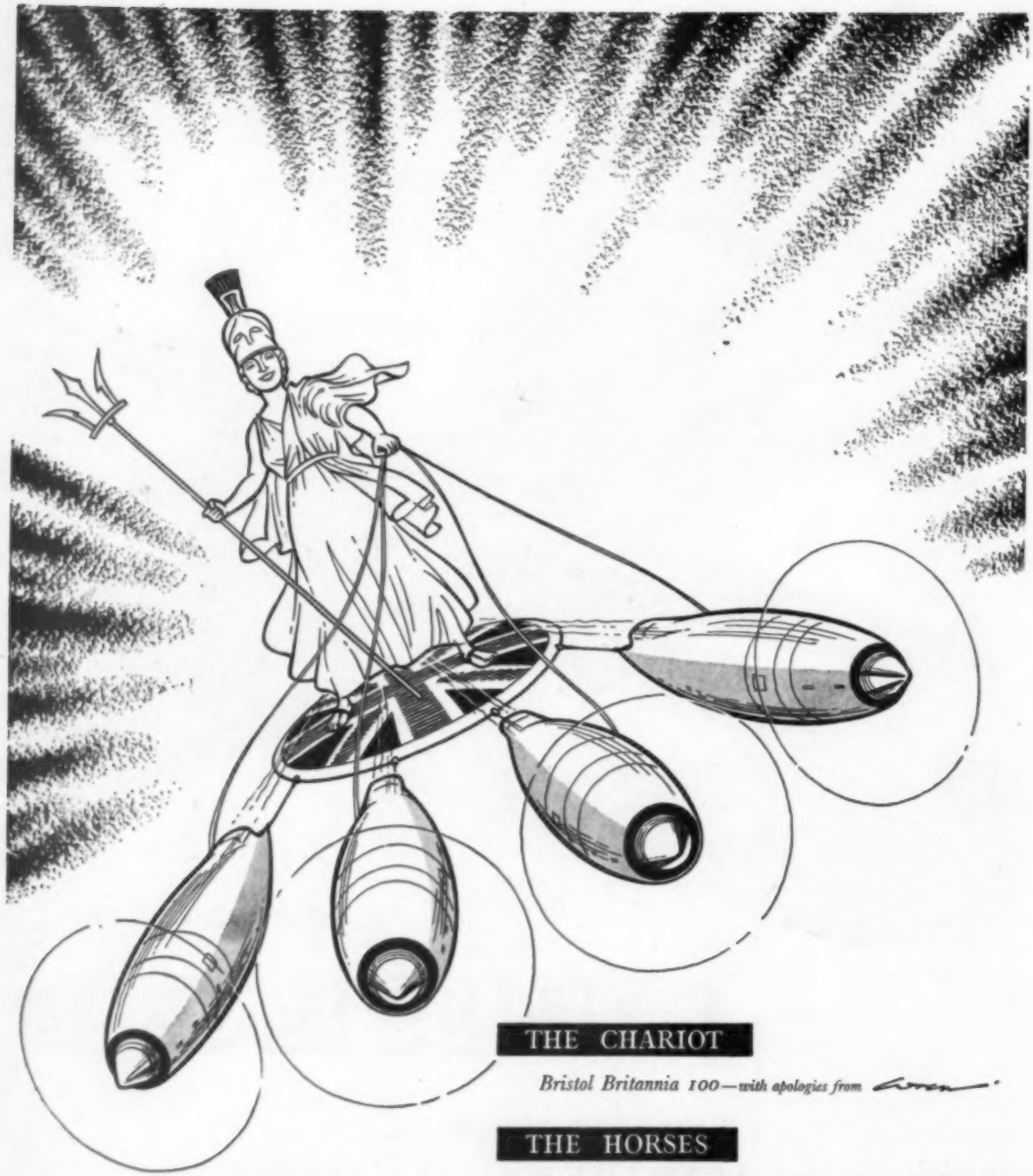

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it may not be severe enough. (This is where temperature "accountability" in the calculation of turbine aircraft performance is brought in to settle all arguments.) Obviously, at some places in the hottest months it will be possible to schedule departures for the cooler hours of the night.

Example: Runway paved length, 8,000ft. Elevation, 1,000ft: correction factor = 1.07. Temperature, 25 deg C (i.e., 12 deg C above 13 deg C standard at 1,000ft): correction factor = 1.12. Combined correction factor = 1.07 × 1.12 = 1.20. Assuming DC-8 or 707 gross-weight take-off field length at sea level and 15 deg C to be 9,000ft (see below), total approximate field length required is 9,000ft × 1.20 = 10,800ft. Thus additional length needed is 10,800 − 8,000ft = 2,800ft.

Clearly this method of determining a runway correction is only an approximation, and special studies have to be made for individual aircraft and airports if accuracy of the first order is required. Where the method produces a correction greater than about 35 per cent (e.g., Entebbe, Johannesburg, Mexico City, Nairobi, Sao Paulo) it becomes less accurate (i.e., too harsh); but for the purpose of this analysis, which seeks to provide a general picture, the method has been regarded as appropriate for every airport. It should be borne in mind that the lengthening figures calculated for some runways may be purely hypothetical, because of permanent local obstructions such as buildings or railways.

Few runways are of less than 150ft width, which is assumed to be adequate for both aircraft, since they are not likely to be more critical than current aircraft in regard to ground-manœuvring, crosswind landings, or instrument approaches.

The most up-to-date figures for the J75-powered DC-8 and 707 (intercontinental versions) gross weight and take-off are as follows: DC-8, 287,500 lb and 8,760ft C.A.A. balanced field length*; Boeing 707, 290,000 lb and 9,000ft B.F.L. There has been talk of these weights being increased over the 300,000 lb mark, and it is possible that this might happen: certainly there are few if any aircraft whose design gross weight has not gone up in the course of development, either to improve payload-range, or just through the growth of structure weight. However, this possibility has been ignored in the present study, and a round figure of 9,000ft for the take-off field length of both aircraft in International Standard Atmosphere conditions, i.e., sea level and 15 deg C, has been assumed for full-weight operation from the main airports.

The assumptions made in gauging the suitability of alternates from the performance aspect are different, being based on the ability of these airports to take the two aircraft at their landing weights. The latter are taken to be 180,000 lb for each machine, giving a landing distance of the order of 6,000ft with reverse thrust. A landing weight of 180,000 lb has been chosen because it is less than the maximum permissible landing weight (about 200,000 lb for each aircraft) and more than the zero fuel weight (about 170,000 for each). The alternate's subsequent ability to enable the aircraft to get out again is assumed not to be critical.

**Accelerate-stop distance assuming engine-cut at critical point.*

ORDER BOOKS
(Correct to April 30th, 1956)

BOEING 707

Customer	No.	Model	Delivery date	Price
PanAm	23	(6) 120 (17) 320	Dec., 1958, to Nov., 1959	$140m app.
American	30	120	From March, 1959	$135m
Braniff	5	120	From Oct., 1959	$30m
Continental ...	4	120	1959	$21.3m
Air France	10	320	Nov., 1959, to Nov., 1960	$71m
Sabena	4	320	From Dec., 1959	$20m app.
T.W.A.	8+ 22 opt.	120	From April, 1959	
Lufthansa	4	320	Spring, 1960	

Total: 88 + 22 options.

DOUGLAS DC-8

Customer	No.	Model	Delivery date	Price
PanAm	25	J57 and J75	From Dec., 1959	$160m
United	30	(15) J57 (15) J75	From May, 1959	$175m
National	6	J57	Midsummer, 1959	$37m
K.L.M.	8+ 4 opt.	J75	From March, 1960	$50m
Eastern	18+ 8 opt.	(6) J57 (12) J75	May, 1959 March, 1960	Incl. opt. $165
J.A.L.	4	J75	1960	$27m plus
S.A.S.	7	J75	1960	App. $50m
Panagra	4	J75	Early 1960	$25m
Swissair	2	J75	Spring, 1960	$16.4m
Delta	6	J57	June, 1959	App. $36m

Total: 110 + 12 options.

The importance of suitable alternates cannot be overrated: without them safe and regular world-wide operations are doomed. Those chosen in this study are the best from the point of view of length and strength. There is no hard-and-fast rule about the choice of an alternate diversion-airport: different airlines often prefer different alternates for the same main terminal, particularly in Europe and the U.S.A. where airports lie thick on the ground. In other parts of the world, of course—e.g., Hong Kong, Fiji—alternates are more critical, and some main airports have few from which to choose. But the majority have what might be termed their "official alternates"—usually airports two or three hundred miles away, out of the same weather area. In picking the best likely diversion airports for the DC-8 and 707 in this study, many of these official alternates have been discarded on the score of length or strength in favour of others that are better in these respects. Some of those rejected were considerably below requirements. Many of those substituted (where possible two for each main airport) shape up poorly, but they are believed to be the best available. Some may be unfamiliar, others may not be usable by operators for economic or other reasons; but when taken altogether they provide the general picture which is the aim of the present analysis. Distances from the respective main airports are given in each case. Their lengths have not been corrected for elevation and temperature, since landing distance is rarely sensitive enough to engine reverse thrust to be taken into account, but elevation and temperature data have been included for good measure. Some of the alternates picked are, of course, main airports in their own right.

Runway length, however, is but half the problem. Ask most airport authorities how their runways will measure up to the DC-8's and 707's runway requirements, and they will perhaps shrug and say that extension plans will be put in hand. Ask them how they will stand up to 290,000 lb gross weights, and they will probably laugh. For very few airports were designed to withstand such mighty loads, and beefing up to the requisite strength will in many instances involve pretty well the complete reinforcing of all runways, taxi-tracks and aprons.

The full-page tables include the bearing strength of each airport. The different forms in which this is presented is a measure of the vagueness that exists about pavement strengths. Most authorities supply a figure for "isolated single-wheel load," a value which is relatively easily established by mechanical test; others quote the maximum gross weight acceptable; some just say "DC-4" and leave it at that (where this is the case the appropriate gross weight has been inserted). The more sophisticated airports give a Load Classification Number, which is the most realistic index of all, since it is the basic *design* parameter, taking into account weight, tyre pressure and undercarriage geometry, and incorporating single-wheel load. The L.C.N. system sets a standard to which both the runway engineer and the aircraft designer can work: without the system it is well-nigh impossible for either to take all the variables into account. The L.C.N. to which the Douglas and Boeing designers are working has not yet been published, but the geometry of each main undercarriage appears to be a conventional bogie (Douglas started off with a co-axial quad, later changing to tandem pairs) and an approximation for *equivalent* isolated single-wheel load can be calculated. This impressive-sounding quantity is that which, at a given tyre pressure, produces the same effect on a pavement as the multiple-wheel load.

Some measure of a four-wheel bogie's load-spreading ability

Load spreader: One of the main bogies of the Boeing 707 prototype.

IMPACT OF THE HEAVY JETS . . .

may be gained from the fact that an airport able to support a hypothetical single-wheel aircraft of 200,000 lb is, generally speaking, strong enough to take a four-wheel bogie aircraft of something like twice the weight. A rough-and-ready calculation of the equivalent i.s.w.l. of a four-wheel bogie may be obtained by multiplying gross weight by 0.22: this is an I.C.A.O. (Annex 14) recommendation, and assuming 290,000 lb for the gross weight of each jet, we arrive at approximately 64,000 lb equivalent i.s.w.l. This at once enables us to see how the two aircraft match up to the main airports which quote their bearing strengths in terms of i.s.w.l. (which is in fact the majority). And if we assume for each type a tyre pressure of 150 lb/sq in we arrive at an L.C.N. number of the order of 80 or 90. For comparison, L.C.N.'s for the Comet 4 and the Britannia 310 lie between 50 and 60.

The strength required of the alternates is not so severe, being based on landing weight. The landing weight of 180,000 lb assumed earlier gives an equivalent i.s.w.l. of 40,000 lb for these airports.

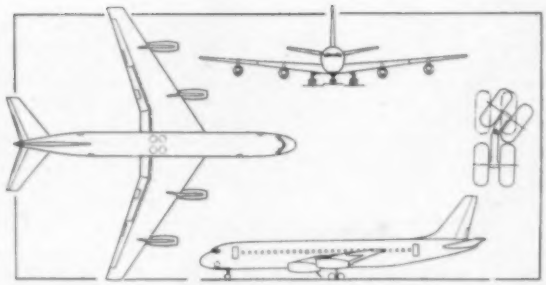
Some airport strengths quoted in the table simply give a gross-weight figure, and in each case for lack of further information it is assumed that this is for dual main-wheel aircraft; by applying a factor of 0.35 (I.C.A.O., Annex 14) an approximation for equivalent i.s.w.l. can be gained. It should be emphasized that this is only an approximation. It is in fact a reversal of the Annex 14 correction factor—which, as previously stated, is intended for application to an aircraft rather than to a runway. Pavement resistance—which depends on its flexibility, aircraft tyre pressure, tyre contact area, aircraft wheelbase and so forth—is an imperfectly understood subject, and each runway has to be considered on its merits. But the 0.35 factor has been applied because it gives the benefit of the doubt. If the airports which quote their runway strengths in terms of maximum acceptable gross weight were *not* analysed in this way, and their "gross weights" taken as the only measure of their strength, it would be found that very few indeed would be able to take the two aircraft.

DC-8 AND 707
Summary of Assumptions

Take-off weights	290,000 lb
Equivalent isolated single-wheel loads	64,000 lb
Take-off field lengths, I.S.A.	9,000ft
Landing weights	180,000 lb
Equivalent isolated single-wheel loads	40,000 lb
Landing field lengths with reverse thrust	6,000ft

If, then, the suitability of each airport is assessed according to the foregoing assumptions, we arrive at the conclusions listed earlier. The writer believes that, in the light of published knowledge about the DC-8 and 707, the assumptions are fair and in certain cases possibly generous; throughout, the benefit of any doubt has been granted. For example, the great majority of the i.s.w.l.s quoted in the table are for considerably lower tyre pressures—often 100 lb/sq in—than the 150 lb/sq in assumed for the DC-8 and 707. The conclusion, in a nutshell, is that before the world can take full advantage of these mighty aircraft, it will need about 150,000ft more runway (of appropriate strength), and 140,000ft of runway overlay (of anything up to a foot thick) to bring existing pavements up to strength. The total cost, assuming round figures of £300 per foot for new runway and £100 per foot for overlay, is of the order of £60 million. And this excludes the imponderable cost of toughening taxi-tracks and aprons.

Here it is appropriate to make a few general observations about airfield pavement design, a branch of engineering which, because of the different conditions—e.g., climate, availability of materials, soil strength and so forth—that occur in practice, is far from being an exact science. The extent to which the world's runways comply with any standard is difficult to assess; many were laid in the war with tarmacadam or 6in-slab concrete surfaces, when the requirements of the future were ignored in the urgent needs of the moment, and very few were designed to calculated standards. London Airport—with its double-slab concrete surface (8in below, 12in top) and heavy base and subgrade—is typical of postwar runway engineering at its best.



General arrangement of the DC-8, with a diagram of the revised four-wheel bogie (changed from the co-axial quad illustrated in "Flight" of July 29th, 1955). Note steerable rear pair.

Strengthening a runway may be carried out in either of two ways. If the extra strength needed is relatively small, a bituminous surface will suffice. For an existing strength of, say, 40,000 lb to 50,000 lb i.s.w.l., about four inches of overlay would be needed to take the heavier loads. For weaker runways, resurfacing with concrete slabs, which may have to be anything up to a foot thick, provides the only satisfactory solution. Resurfacing, it should be pointed out, is always an awkward undertaking because of the serious dislocation to traffic it causes.

A point that has to be seriously considered in runway design is the effect of repeated loads on strength, and here it is a sobering thought that taxi-tracks, which—because of their more confined area—receive more repetitions of maximum load than do main runways, must be at the very least as tough as the runways they serve. Statistics show the actual movement-repetition ratio of taxi-track to runway to be about 10:1 Taxi-ways, and even more so the aprons and hardstandings, in fact have to bear the full brunt of the worst possible loading condition—that imposed by the slowly moving fully-laden aircraft. And if, as shown, the majority of runways are below strength, it is fair to assume that an even greater majority of subsidiary airport pavement is too. It seems that there are good business prospects for the world's runway contractors—and for the makers of medium-weight airliners.

CONCLUSIONS

Of the 58 main airports considered:	
Number suitable	1
Number suitable after completion of current work	2
Number deficient in length or strength	30
Number deficient in length *and* strength	25
Of the 80 diversion airports considered:	
Number suitable	57
Number deficient in length or strength	20
Number deficient in length *and* strength	3

AIRLINER IDENTIFICATION

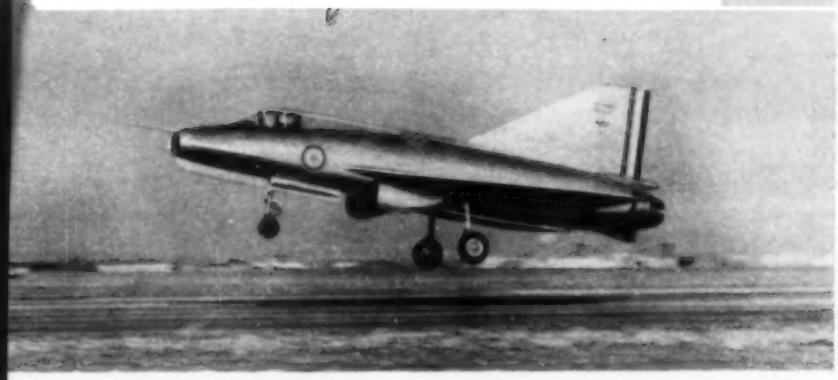
"Know Your Airliners," by John W. R. Taylor and Roy Cross. Published for Shell-Mex and B.P., Ltd., (though not available from that company), by Perry Colour Books, Ltd., and Educational Productions, Ltd., 11 Buckingham Street, London, W.C.2. Illustrated. Price 2s 6d.

IT would require a very long search of the aeronautical bookshelf to find a better half-crown's worth than *Know Your Airliners*, a joint effort by John W. R. Taylor and Roy Cross. The purpose of the book is to describe briefly and illustrate 28 leading types of transport aircraft, and it contains three-view silhouettes of each. In one respect, however, it is a recognition book with a difference: the conventional photographic illustrations have given place to a superb set of Roy Cross paintings, which are reproduced in full colour. Also shown in colour, for the first time, are the badges of all the major airliners serving British airports. The book's attractive appearance and low price should guarantee it a wide sale among the airport-visiting public.

"FLIGHT" PHOTOGRAPHS

MANY of the photographs reproduced in *Flight*, i.e., those taken by our own photographic staff (as indicated on publication) are subsequently available in the form of high-quality prints. Prices are as follows (dimensions given in inches): $5\frac{1}{2} \times 3\frac{1}{2}$, 1s 4d (glossy or semi-matt, unmounted) or 2s (toned sepia, unmounted); 6×4, 2s 6d or 4s; 8×6 3s 6d or 5s 6d; 10×8, 5s or 7s 10d; 12×10, 6s or 9s 8d; 15×12, 9s 6d or 13s; 20×16 (semi-matt only), 13s or 18s.

Also available are a postcard series, totalling over 200, depicting both historic and modern aircraft of the R.F.C., R.N.A.S., R.A.F. and Fleet Air Arm. Complete lists of the series are obtainable on application. Prices are 8d each card, or $7\frac{1}{2}$d each for quantities of a dozen or more. One view only—in most cases a good three-quarter front or side—is available for each aircraft type. Available, too, as postcards, at the same prices, are reproductions of general-arrangement drawings of some 20 British aircraft that have appeared in our "Aircraft Intelligence" pages.



The S.E.212 Durandal taking off on its first flight at Istres recently (see paragraph below). Notable features are the knife-edge windscreen, long ventral strake under the forward fuselage, rocket motor housing under the aft fuselage and very large fin area.

AIRCRAFT INTELLIGENCE

Boeing B-47B Stratojet. The first aircraft—a B-47B—destined to be a jet-propelled "hurricane hunter" left the Boeing plant at Seattle on March 26th for White Plains, N.Y., for modification as a U.S.A.F. meteorological aircraft. It will make high-altitude checks on tropical cyclones, while specially fitted B-29s and B-50s continue in their work of low and medium level observation within the storms.

Beech T-34B Mentor. The U.S. Navy has placed a second order for an unspecified number of T-34B Mentors to a value of $4m. The type has been in production for the Navy since 1954 and was phased in as a basic trainer at N.A.S. Pensacola last November. It is gradually replacing the SNJ (Harvard).

France

Bréguet 901. Including the prototype, five Bréguet 901 high-performance gliders have now been completed. During the World Gliding Championships at Saint Yan this summer two will be used by the French team and six others will be loaned to American, Canadian, Australian, North African, Japanese and Swedish competitors.

S.N.C.A.S.E. 210 *Caravelle.* Following the French participation in the Royal Easter Show in Sydney and a subsequent world-wide tour by M. Georges Hereil, president and director-general of S.N.C.A.S.E., it is reported that orders for the Caravelle are being negotiated with several of the world's airlines.

S.N.C.A.S.E. 212 *Durandal.* The first flight of this new delta-winged intercepter was made at Istres on April 21st. At the moment is has only the power of a S.N.E.C.M.A. Atar, with variable-area efflux, but the housing for the rocket motor, which will later make it supersonic, is already to be seen under the after fuselage. The windscreen is a knife-edged structure, apparently without a central "spine". Main-wheel retraction appears similar in layout to that of the Nord Griffon. A long ventral strake extends from the lip of the intake back to the level of the wing leading edge, crossing the nosewheel-bay door. The nosewheel appears to be hydraulically steerable, and the wing is very thin. Taxying trials were carried out at the maker's airfield by Pierre Maulandi and either he or Cmdt. Carpentier made the first flight.

S.N.C.A.S.O. Helicopters. Mr. Don R. Berlin, president of the Vertol Aircraft Corporation (formerly the Piasecki Helicopter Corporation) and M. Glasser, president-director-general of S.N.C.A.S.O., recently reported an agreement between their two firms for the supply by S.N.C.A.S.O. to the French Government of a large number of H-21C helicopters. Deliveries will begin in June and will continue for a year. The agreement further stipulates that supplies may be continued subsequently with aircraft manufactured under licence by S.N.C.A.S.O.

Czechoslovakia

Praga E-11. Designed by T. Slechta, this multi-purpose light aircraft recently won a design competition. It resembles the Boeing L-15 in appearance, but has a nosewheel undercarriage. There is side-by-side seating for two people in front, and a single rear seat. Duties originally intended for the E-11 included agricultural, ambulance, liaison and A.O.P. work. A Walter Minor 6III engine of 160 h.p. was fitted, but with this unit the machine was found to be underpowered and production was cancelled. The prototype is being used for parachute jumping.

The 1956 version of the C-46—the work of two aviation firms, L. B. Smith and Air Carrier, in Miami.

SUPER COMMANDO

C.A.A. Approval for a Modernized 55-Passenger Curtiss C-46

AERONAUTICAL-ANTIQUE lovers are always delighted when an old aircraft is given a new lease of life; and when the aircraft concerned is a transport their pleasure is shared by capacity-hungry operators. The Curtiss C-46 Commando, built in large numbers during the last war as the military version of the Curtiss CW-20 36-passenger airliner of 1939, is still doing a good job for the smaller operators all over the world. It has, like the ageless DC-3, worn the years well, and it is not surprising that someone should have foreseen good business for an improved version more in line with the needs of today.

In 1954 two aviation firms in Miami, Florida—Air Carrier Engineering Services and the L.B. Smith Aircraft Corporation—acquired from the U.S.A.F. a standard C-46F, and three weeks ago came due reward for designing, engineering and testing some 30 engine and airframe improvements—a full C.A.A. Certificate of Airworthiness. Known again by the original designation CW-20—actually CW-20T— similarly modified C-46s are thus cleared for unrestricted use by scheduled passenger airlines throughout the world. The modifications required vary according to whether the aircraft concerned is a standard C-46F or one of the earlier C-46 types.

The major alteration is the installation of Pratt and Whitney R-2800C engines of 2,400 h.p. in place of R-2800-51s of 2,000 h.p., with a new secondary firewall of stainless steel, and a completely new fire-extinguishing system for the engine accessories and wheel wells. As a result of the engine change the firewall is altered so that all equipment is mounted aft, and a Convair-type oil cooler is installed to give increased cooling. As may be seen from the lower right-hand photograph, the bottom part of the cowling has been refashioned to accommodate the larger duct, the engine cooling flaps moved from the bottom to the top, and the upper portions of the cowling reworked to accommodate a larger carburetter air intake with a relocated outlet. A new secondary firewall, which completely separates the power and accessory sections of the engine, has been added and a new stainless-steel cowling installed round the accessories. In addition, a portion of the nacelle aft of the main firewall is protected with heavy gauge stainless steel, and the emergency fuel system transfer arrangements have been considerably improved; the undercarriage of the earlier types of C-46, both main wheels and tail wheel, have been strengthened and a more powerful braking system installed. DC-6-type wheels have been used in place of the standard wheels, and modifications made to the tail surfaces of the early C-46.

Although full details of performance have not yet been officially released some indication of the improvements that the modifications bring about can be given. The extra 800 h.p. is expected to permit the raising of gross weight by nearly 3,000 lb to 47,650 lb, which will mean that at least ten more passengers can be carried. Although seating arrangements are optional, the C.A.A. certificate permits maximum high-density accommodation for 55 passengers, compared with the 40 to 44 passengers usually seated in the standard aircraft.

Other provisional performance figures are as follows: cruising speed at 16,200ft (using 1,600 h.p. from each engine), 277 m.p.h.; cruising speed at 10,000ft (1,200 h.p.), 225 m.p.h.; endurance at cruising speed, with 400 U.S. gal., 7.3 hr; range at cruising speed, 1,635 st. miles; climb to 10,000ft, 9 min; service ceiling, 26,000ft; single engined ceiling, 10,200ft.

No details have been given of the full cost of the complete modernization, but it is believed that the cost of the seven modifications to the undercarriage and tail surfaces of the early type C-46 would be in the region of £8,500.

The original Pratt and Whitney 2,000 h.p. R-2800-51 of the standard C-46 (left) compared with the 2,400 h.p. Pratt and Whitney R-2800C with which the new version of the C-46 is powered. Note the re-positioning of the engine cooling gills. Both the upper and lower intake ducts, respectively for the carburetter and the oil cooler, have been enlarged. Much of the cowling around the accessories and aft of the firewall is of stainless steel. Nine months of flight-testing preceded the C.A.A.'s award of a certificate of airworthiness.

F A I R E Y

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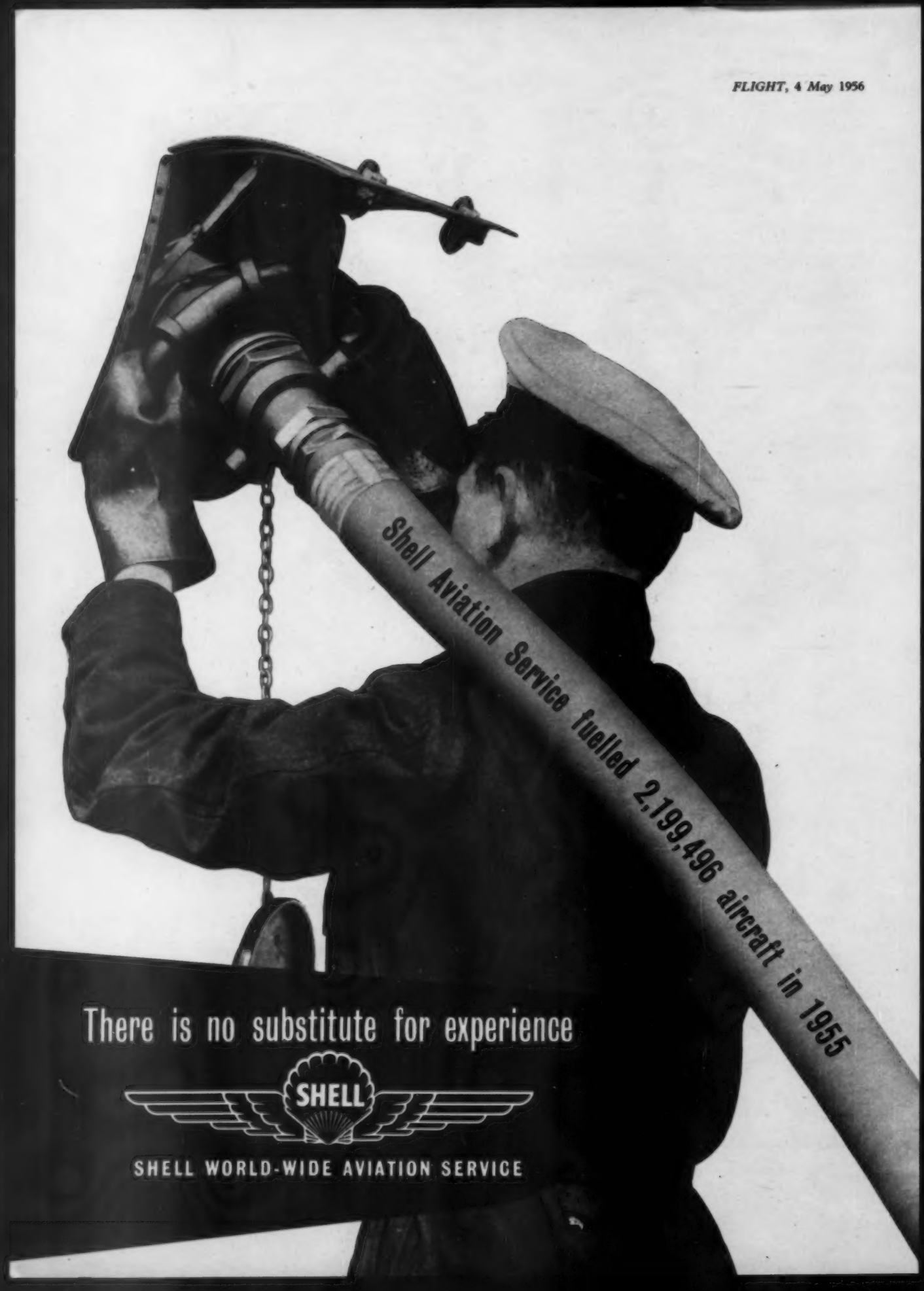
Shell Aviation Service fuelled 2,199,496 aircraft in 1955
There is no substitute for experience
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Power Supplies in Earth Satellites

British Interplanetary Society Discuss Utilization of Solar Energy

SOME aspects of instrumentation suitable for use in satellite vehicles similar to some of those to be launched in the next year or so, and the means for providing power for their operation, were discussed in a lecture given by E. C. White, R. G. Wilkins, and J. Foley to the British Interplanetary Society at their April meeting at Caxton Hall, London. The authors had been considering, independently of the official satellite programmes, the problems raised by the necessity to operate measuring and telemetry equipment for much longer periods than have been called for in high-altitude research conducted with rockets. They concluded that where a satellite was to work for more than a few hours battery power would be quite impracticable, and that the best solution was to use solar energy converted to electrical power by silicon photocell wafers.

The first of the evening's papers considered the merits and disadvantages of different possible orbits for the satellite. With satellite heights of about 100 miles, atmospheric friction is sufficiently great to slow up and destroy the satellite in about an hour, or less than the time required for a complete circuit of the earth. As the height is increased the atmosphere becomes negligible in effect and a satellite initially in orbit at a height of 200 miles has an estimated flight-time of 15 days. Where sunlight is needed as a source of power many orbits suffer the disadvantage of being partially shadowed by the earth, the worst case being that in which the satellite orbit is in the same plane as the earth's orbit round the sun. Interesting points about this case are that with a satellite height of less than 1,000 miles the satellite is in shadow for between one-third and a half of the time, and that the duration of shadow experienced by the satellite is a minimum at a height of about 800 miles. The shape of the earth's shadow, which also plays an important part, was shown to be effectively cylindrical, the penumbra having only a small effect.

The purpose of the satellite was next considered, together with the difficulties imposed by lengthy periods of operation. Even in the best circumstances, high-altitude rockets give only a few minutes of flight when measurements of conditions outside the atmosphere can be made; but the satellite makes possible investigations into primary cosmic rays and observations of solar radiation and particle streams over periods of hours or days. Therefore equipment must be devised which will work reliably and transmit accurate information over far longer periods than have been used in rocket flights so far. The need for conservative rating of components and great economy in power consumption led to the proposal that a receiver and data-storage circuits should be included in the satellite and that information should be transmitted only when the ground receiving-station was ready for it, and had transmitted the appropriate signal to the satellite. Certain of the more highly rated components, in particular the transmitter, would have to be duplicated in order that failure of one component should not render the great expense of launching the satellite a complete waste.

A selection of instruments and equipment which would form a likely load for a satellite was taken and their weights and power requirements estimated. On account of their small dimensions and their reliability transistors were suggested as very suitable circuit elements for the data-storage equipment (a pulse counter), for the modulator for the transmitter, and for power supply converters. The table below shows the weight and power required for two satellites performing similar duties. The first is intended to transmit continuously and the second to transmit only when it receives a "request for information" in the form of a radio signal from the earth.

The final paper was concerned with the methods of converting and storing the sun's energy. After pointing out that it was much more important to get a large output from a small weight, rather than have a unit which was highly efficient as a power converter, the speaker went on to eliminate heat engines using solar boilers as being far too complex for satellites of the small weight and size being considered.

The other alternatives were thermopiles and photocell converters. The former could be made to give 6 Watts output per pound weight, and might have a conversion efficiency of 7 per cent, but it was necessary to direct one set of intermetallic junctions towards the sun, and keep the other set in shadow. The mechanical arrangements to ensure this were not likely to be worth while. Photocell converters could give an output of 17 Watts per pound weight and convert solar energy with an efficiency of 12 per cent. These cells were made from silicon containing a carefully introduced trace element in its surface layer; a voltage was developed across the interface between this layer and the pure silicon when solar radiation fell on the cell. The whole surface of the sphere could be covered with a mosaic of cells, which would also need a transparent protective shield to prevent damage by micrometeorites.

The need for measurements to be made, and possibly for information to be transmitted, while the satellite is in the earth's shadow made it necessary to store some energy in the satellite. It was found that the weight of the necessary cells reduced the Watts per pound figure from 17 to 14.

Component	Continuous Transmission		Periodic Transmission	
	Mean power (Watts)	Weight (lb)	Mean power (Watts)	Weight (lb)
Two Geiger counter tubes ...	2.75	0.8	2.75	0.8
Resistance thermometer ...	1.53	0.25	1.53	0.25
Photocell	0.82	0.35	0.82	0.35
Transmitter, duplicated... ...	8	1.5	0.48	1.5
Switch motor	6	1	0.36	1
Modulator...	1	1	0.06	1
Data storage	—	—	0.31	1.6
Receiver	—	—	2.85	0.35
Power converters	3	2	1.65	2.5
Totals	23.1	6.9	10.9	9.4

MINUS FOUR TURBOJETS, PLUS TWO TURBOPROPS: AN UNUSUAL B-47

This XB-47D is one of two modified—by Boeing for the U.S.A.F.—to serve as test beds for the new Curtiss-Wright T49 turboprop, two of which replace the usual inboard turbojets in their double pods. The outboard engines are the normal General Electric J47s. Four-blade Curtiss turbo-electric airscrews, each 15ft in diameter, with paddle-type blades 24in wide and ducted spinners, are used in conjunction with the T49s.

NAVY

NAVY

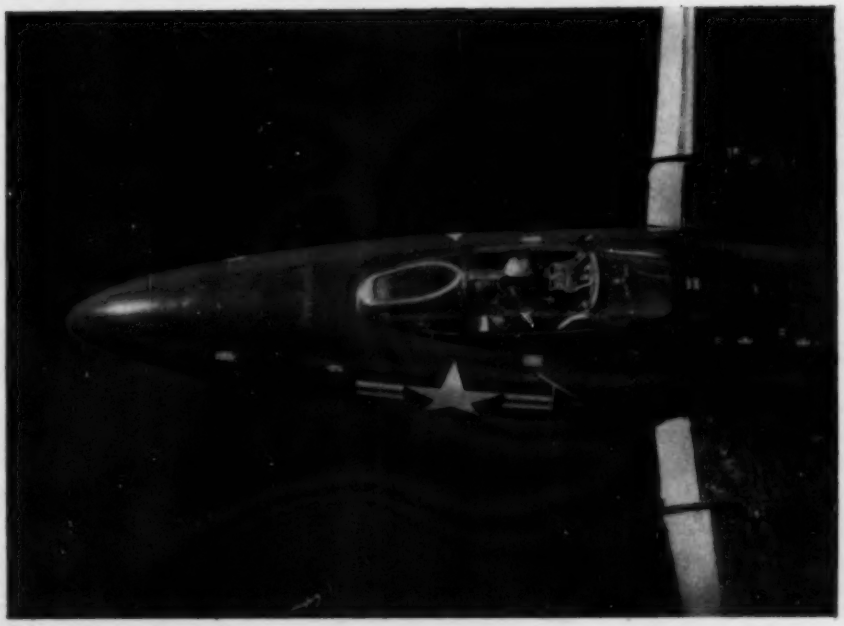
NAVY

GAGGLE OF GRUMMANS

NO finer air-to-air photographs come out of the U.S.A. than those by Harold G. Martin, and reproduced here are some of the best examples of his more recent work. Of particular merit, in point of photographic quality and dramatic effect, are the close-ups on this page, that above depicting the business end of a Grumman F9F-6P Cougar carrier-borne photographic-reconnaissance aircraft, and that on the right an F9F-5 Panther. Banking towards the camera on the opposite page is an F9F-7 Cougar. In the original print of the Cougar picture above, every scratch on the wing surface is clearly visible and interest is added by the experimental spoilers for lateral control. These are standardized on the supersonic Tiger.

The two trim amphibians at the top of the opposite page are, respectively, a G-73 Mallard and a G-44A Widgeon. Then, in a U.S.A.F./U.S. Navy alliance come a North American F-86A Sabre and an F9F-6 Cougar.

Last—with a lateral stabilizing float of the photographic Mallard intruding—is an S2F Sentinel anti-submarine aircraft.



THE A.R.A. TUNNEL

A Co-operative Research Facility for the British Industry: Inauguration Today

THE transonic wind tunnel of the Aircraft Research Association at Bedford is due to be officially opened by His Royal Highness the Duke of Edinburgh, at noon today, May 4th. Editorial comment on this significant occasion is given in a leading article in this issue; and on this and the following five pages the development history, design and construction of the installation are described.

FOR a considerable number of years it has been generally acknowledged that the British aircraft industry has been handicapped by a lack of really capable test equipment of the type necessary for the development of high-speed aircraft. In particular, a serious shortage has existed of transonic and supersonic tunnels large enough to accommodate a reasonable size of model.

Very substantial expenditure has now resulted in the commissioning of excellent high-speed tunnels at the R.A.E., both at Farnborough (the modification of an existing tunnel) and at Bedford. Nevertheless, these tunnels, being Government property, can never fully serve the requirements of the industry for *ad hoc* developments. Realizing this, some companies have constructed their own tunnels, generally using the induction-type layout with turbojet power in order to effect substantial economies in capital cost. It is safe to say that no single British aircraft company would have been willing to spend the seven-figure sum necessary for the construction and equipment of a large, high-speed tunnel capable of continuous operation. During the early part of the present decade, the idea of forming a co-operative group of firms who would pool their resources in a single establishment for the mutual benefit of all was discussed at length. Formal talks were then held under the sponsorship of the Society of British Aircraft Constructors, whose technical committee acted as a general supervisory body at this stage.

On February 13th, 1952, a meeting was held in the old S.B.A.C. office at Savile Row, London, at which the Aircraft Research Association was formed as a company limited by guarantee on a non-profit-making basis, and approved by the Department of Scientific Research as a research organization. A small London office was obtained and Mr. R. Hills, B.A., A.F.R.Ae.S., was appointed chief executive.

The governing body of the A.R.A. was established as a committee consisting of one director from each of the aircraft companies interested in the tunnel. Originally these comprised all the major manufacturers apart from de Havilland, English Electric and Short and Harland, but Fairey later withdrew (after significantly assisting in the tunnel design) to leave the 14 named in the accompanying list, which includes two of the chief British aero-engine manufacturers. These companies each contributed towards the capital cost of the tunnel, and the use of the tunnel will be made available to each firm in the proportion in which they paid for it. Running expenses will be paid by the member firms in proportion to their own occupation of the facility, the rate per hour being so chosen as to cover all overheads exactly.

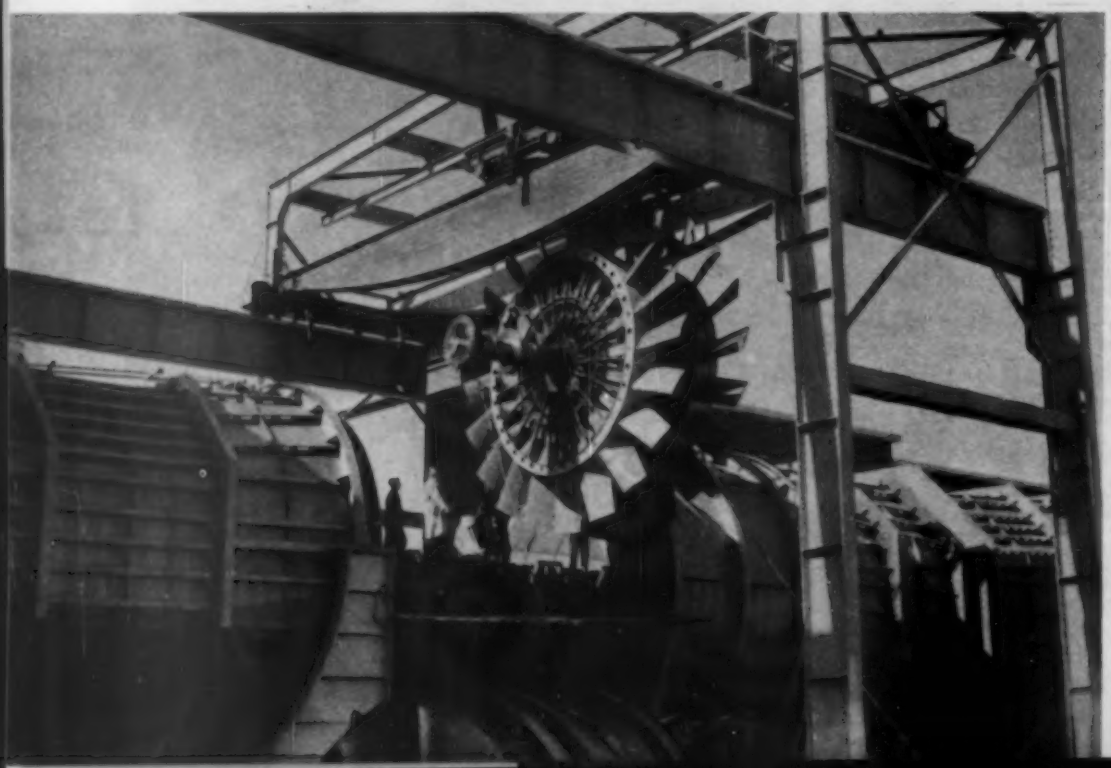
At present no particular difficulty is foreseen in the operation of the venture. Should one manufacturer tend to monopolize the tunnel, it may be necessary to follow the practice established at the Southern California Co-operative Tunnel at Pasadena, in which the proportion of each year's time remaining is allocated inversely according to the amount each company has already had. Already the A.R.A. tunnel is booked up at least a year ahead and, should any company not be in a position to make use of time due to it, the facility will automatically become available to the next firm in the queue. It is expected that the same rate-per-hour will be charged to each user, although an increased rate may be charged to companies who are not A.R.A. members.

Model-making for high-speed tunnels is an exceedingly large and complicated job requiring the utmost precision; a complex high-tensile-steel model may easily cost £10,000 and take a year to manufacture. Firms intending to use the tunnel will bring their own models, which will be prepared in closed bays in order to preserve the secrecy of each new project. The operation of the tunnel and reduction of results will, in normal circumstances, be done entirely by A.R.A. staff, who should become widely experienced and acquire considerable value as consultants. They will be bound on oath to keep all results strictly confidential between the A.R.A. and the company concerned.

Should there be any spare time the tunnel may be used for more general tests of interest to several A.R.A. firms. As already stated, however, the new tunnel is not intended for basic research but will be employed almost entirely on *ad hoc* testing of individual members' projects.

The location of the tunnel site was one of the first essentials to be decided. A suitable supply of electric power was needed together with a supply of water for cooling, and it was finally decided that the Bedford area combined many advantages. A site close to the Royal Aircraft Establishment at Bedford, in particular, would be extremely convenient. Having selected the general area, finding a specific site presented further problems. Several had to be abandoned for reasons such as town planning requirements and agricultural needs, and many discussions took place with the various local authorities.

Concurrently with the search for a suitable site the design of the tunnel was being formulated. It was decided that the tunnel



Scale is given to this photograph, taken during the installation of the two-stage fan, by the engineers supervising the positioning of the unit.

This impressive "Flight" photograph reveals the general layout of the A.R.A. tunnel buildings at Bedford, as seen from the air.

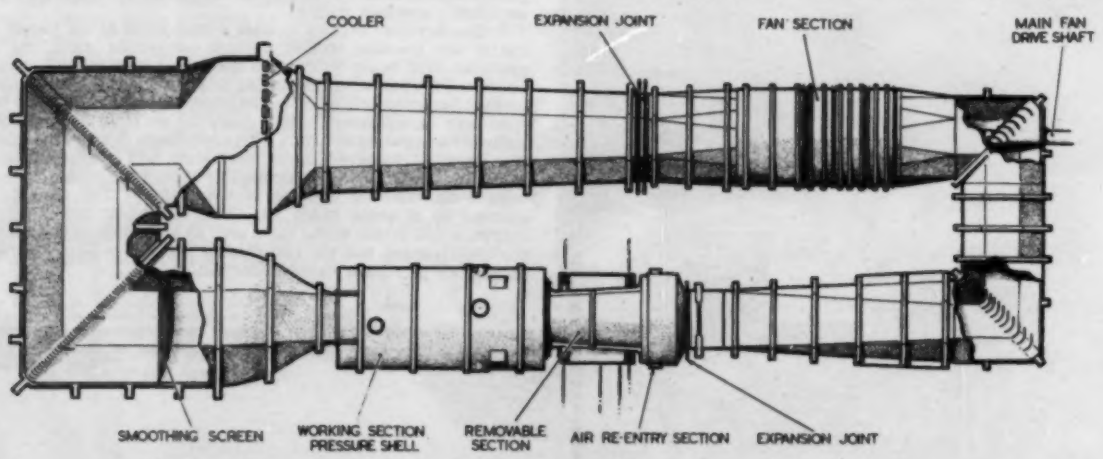
should incorporate perforated walls and that the working section size would be 9ft wide × 8ft high, enabling models of about 3ft span to be tested. At the speed of sound this gives a Reynolds Number of about 4×10^6 at atmospheric stagnation pressure. During the second half of 1952 the detailed design of the tunnel was started, and the first order for the construction of the main shell was placed with Moreland Hayne and Co., Ltd., in September of that year. Two months later the order was placed for the main 25,000 h.p. electric motor with the English Electric Co.

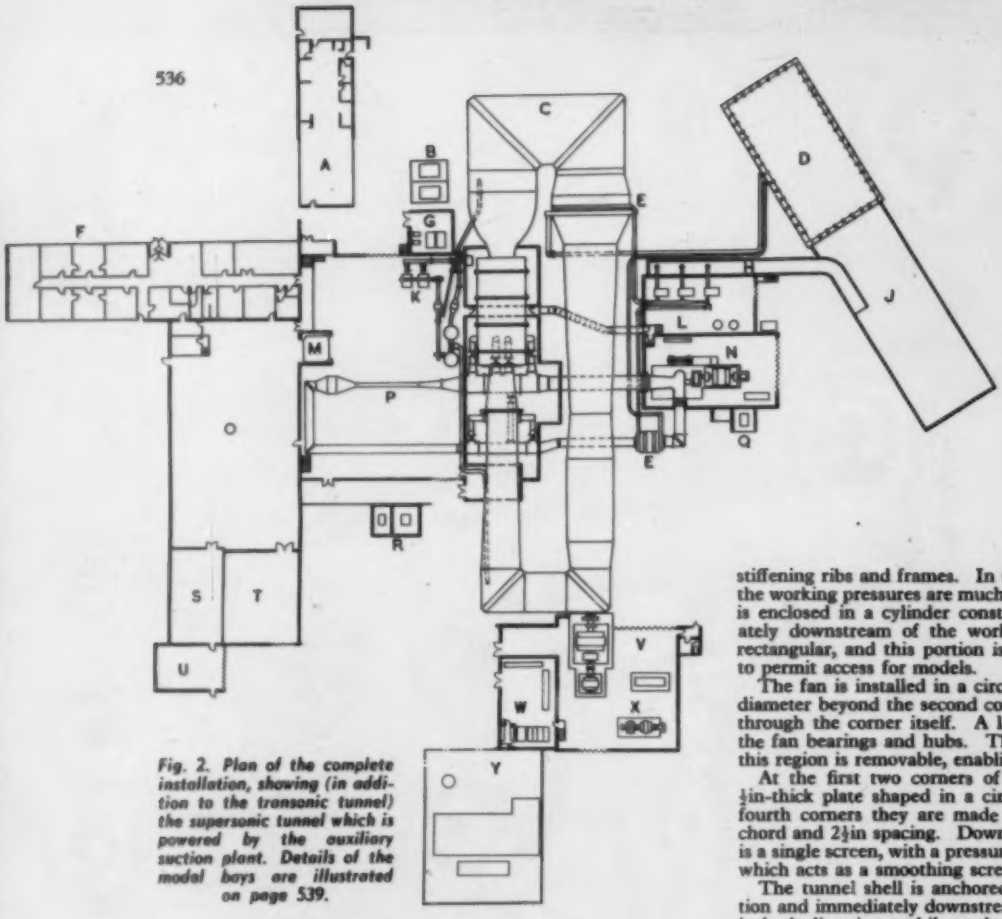
Assistance in the design of the tunnel and in model test work was received from the R.A.E. Farnborough, Fairey Aviation, and American private firms and government research establishments. Building work on the site began in October 1953 and the first part of the tunnel shell was erected in the following August. All work on the transonic tunnel itself has now been completed and only calibration is required before it is ready for tests on models for member firms. Present Mach-number range is 0.7—1.3.

During the course of the design of the transonic tunnel it was decided to add a smaller supersonic tunnel which would be powered by the auxiliary suction plant already provided for the larger tunnel. The working section is 2½ft × 2½ft and the tunnel will cover a speed range from M = 1.6 to about 3.4. Completion of this supersonic tunnel is planned for early 1957.

In addition, a smaller transonic tunnel having a working section 9in × 8in is being built. This will be an intermittent tunnel driven from the dry-air storage supply being provided for the supersonic tunnel. It will be particularly valuable for preliminary tests of model rigs prior to their use in the main transonic

Fig. 1. The main transonic tunnel circuit is of conventional closed type. Flexible walls and perforated walls are features of the working section.





A Canteen.
B Oil fuel tanks.
C Transonic wind-tunnel.
D Cooling tower.
E Cooler.
F Offices.
G Boiler house.
H Aqueduct.
J Reservoir.
K Air-drying plant.
L Water pumps.
M Lift.
N Auxiliary suction plant.
O Model making workshop.
P Supersonic wind-tunnel.
Q Auto-starter.
R Low-tension transformers.
S Wood shop.
T Stores.
U Garage.
V Main fan drive motors.
W 11 kV switchgear.
X Motor generator set.
Y 132 kV/11 kV transformer.

Fig. 2. Plan of the complete installation, showing (in addition to the transonic tunnel) the supersonic tunnel which is powered by the auxiliary suction plant. Details of the model bays are illustrated on page 539.

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tunnel. It is intended to equip this small tunnel with Schlieren apparatus for the investigation of shock-wave patterns. The intention in providing supersonic facilities was to ensure that the A.R.A. will be capable of providing aerodynamic information for the design of the next generation of aircraft, which will fly at Mach numbers of between 2 and 3. Aerodynamic problems associated with guided missiles will also be investigated.

Structural Design of the Tunnel. As shown in Fig. 1 the main tunnel circuit is of the conventional closed type, the main fan drive consisting of two stages on the same shaft. The circuit includes a cooler and a smoothing screen.

For reasons of simplicity it was decided to operate the tunnel at not more than ½ atmosphere above or below atmospheric pressure. Thus an octagonal cross-section could be used over most of the circuit, the structure comprising ¼in-thick flat plates with stiffening ribs and frames. In the region of the working section the working pressures are much lower, and this part of the tunnel is enclosed in a cylinder constructed from ¼in plate. Immediately downstream of the working section the cross-section is rectangular, and this portion is mounted on a movable carriage to permit access for models.

The fan is installed in a circular section of the tunnel 21ft in diameter beyond the second corner, with the shaft drive passing through the corner itself. A large bullet-shaped fairing houses the fan bearings and hubs. The top part of the tunnel shell in this region is removable, enabling the fan to be installed.

At the first two corners of the circuit the vanes consist of ½in-thick plate shaped in a circular arc, while at the third and fourth corners they are made from thin curved plates of 10in chord and 2½in spacing. Downstream of the fourth corner there is a single screen, with a pressure drop of twice the dynamic head, which acts as a smoothing screen ahead of the contraction cone.

The tunnel shell is anchored at four points. At the fan section and immediately downstream of the fourth corner it is fixed in both directions, while at the other two points it is secured in the longitudinal direction only. Expansion and contraction caused by temperature changes are accommodated by two expansion joints, one in each of the longer legs of the tunnel.

Working Section. In the design of the tunnel Mr. Hills and his nucleus of staff were given a free hand to evolve the most efficient and up-to-date installations that could be provided. At the outset the tunnel was visualized as being wholly subsonic with a maximum Mach number in the working section of 0.9. By the time the design was begun in earnest in 1952, the work of John Stack and his colleagues at the N.A.C.A. was understood and plans were therefore drawn up for a transonic tunnel with a working section 10ft by 8ft. During the course of design, changes were made resulting in a final size of 9ft by 8ft and a Mach-number range of 0.7 to 1.3, with an extension to the upper limit as far as about 1.6 proposed as a future modification.

During the latter part of 1952 and early 1953 the final design of the working section was evolved, and it is singularly advanced in conception and elegant in execution. In a conventional working section the air chokes somewhere short of the speed of sound and transonic performance can never be obtained, no matter how much horsepower is expended in attempting to pump the air around. Furthermore, shock waves from the model are reflected from the tunnel walls back to the model or its supporting sting, preventing the achievement of representative flow and leading to completely spurious results.

It was therefore decided to suck a proportion of the tunnel air out of the working section through perforated walls, the air extracted then being returned to the tunnel further downstream. In the A.R.A. tunnel the main fan drive of 25,000 h.p. is supplemented by an additional 3:1 compressor driven by a 13,000 h.p. (two-hour rating) motor which sucks the air from the ventilated walls of the working section. This compressor is actually situated in a separate circuit which, as mentioned, will be coupled up at a future date to constitute a complete supersonic tunnel in itself, with a flexible-wall working section 2½ft by 2½ft capable of running up to about Mach 3.4. This supersonic tunnel cannot be run at full power at the same time as maximum-speed runs in the main tunnel, but the two tunnels together will complement each other in a most valuable fashion.

Another aerial view of the site which, in conjunction with the diagram above, identifies the various constituent sections of the new facility.
"Flight" photograph

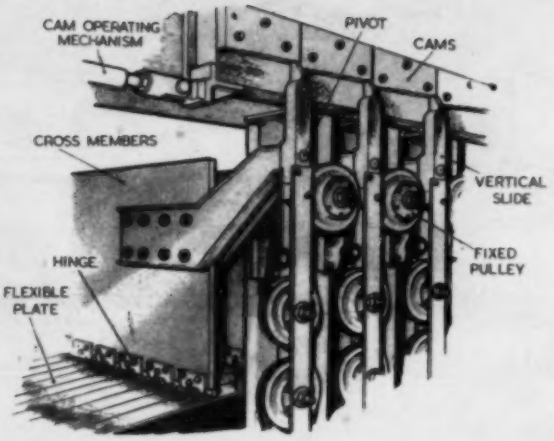

Fig. 3. Adjustment mechanism for the flexible top and bottom plates of the working-section nozzle. Nine steps on each cam cover a range of Mach numbers from 1.15 to 1.6.

Returning to the main tunnel, the boundary layer growth at the entry to the working section is fairly rapid, so that the central core of air is speeded up owing to the reduced effective cross-section for its passage. The wall angle of the working section has therefore been made adjustable according to the proportion of the total flow which is sucked out through the external circuit. By this means the growth of the boundary layer can be so controlled as to maintain the correct "core" size for uniform Mach number throughout the working section. In addition a diffuser flap was incorporated in the design at the downstream end of the working section. The flow turning the corner at this flap has a supersonic (Prandtl-Meyer) expansion which makes the local flow even faster than that in the core of the tunnel. This then serves as an injector pump to suck air out through the slot between the diffuser flap and downstream wall of the tunnel, and so augments the auxiliary suction plant which sucks the air out through the porous walls.

Another advantage of employing porous walls is that they may be made just sufficiently homogeneous to avoid the reflection of shockwaves from the model. In an open-jet tunnel a shockwave is reflected as a rarefaction and it is possible to obtain perforated sheet with a porosity ratio (the proportion of the total area occupied by the holes) such that at one operating condition the strength of reflected shocks is zero. This is, of course, of interest only in the transonic regime; at higher Mach numbers reflected shockwaves should miss the model completely, the wave-angle being 45 deg at Mach 1.41 and 60 deg at Mach 2.

The general arrangement of the working section is illustrated in Fig. 5. The upstream section incorporates fixed parallel side-walls, the floor and roof being adjustable in profile to form the nozzle shapes required for various speeds between Mach 1 and 1.6.

All four walls are built up from strips of cold drawn steel 4in × ¼in (floor and roof) and 5in × ¼in (side walls). These are secured by countersunk bolts at intervals of approximately 13½in to cross members, the holes being filled with Araldite to present a smooth surface to the wind stream. The longitudinal joints between the individual planks are sealed with rubber strips to prevent any leakage of air. Since the surface of the planks is equivalent in flatness to a good machined surface, this method of construction avoids the expensive machining of single plates which would be 25ft long and eight or nine feet wide. The adjustment in profile of the top and bottom plates (see Fig. 3) is obtained by securing the cross members by pivots to vertical slides on each side. The vertical position of each slide is determined by a cam which is cut in a series of steps. Under working conditions the vertical slide is positioned against the cam by a rope passing around a pulley which is fixed to the slide. The vertical position of the slide, and hence the profile of the plate, is altered by pulling the slide away from the cam by another rope and pulley. The cam can then be moved along one step and the slide repositioned on the cam. All the cams on one side are joined together so that they are all moved at the same time, and similarly a single rope operates all the pulleys moving in one direction on one side. Tension in the rope is maintained at about 4,000 lb by a slip-ring motor designed to produce a high torque at zero speed.

Nine different steps are provided on each cam, giving nine different shapes of supersonic nozzle corresponding to the series from $M = 1.15$ to 1.6 at intervals of $M = 0.05$. The higher speeds are provided to allow for future development of the tunnel. Control is by means of push buttons on the control desk in the observation room, intermediate Mach numbers being obtained by varying the amount of suction (typically three to eight per cent of the main tunnel flow) through the perforated walls.

Immediately downstream of this flexible nozzle (made by Chatwood Safe and Engineering) is a 12ft long section in which all four walls consist of perforated plates. The models, the length of which will not be greater than about 6ft, are placed in the rear of this section. At the junction between the perforated plates and the upstream section, the joint takes the form of a serration having teeth at 45 deg. At speeds below Mach 1.4, therefore, the flow at right angles to any step in this joint will be subsonic and there is no possibility of a shockwave being produced by these steps.

The top and bottom walls in this section are fixed while the side walls can be flexed about their upstream ends by approximately ± 1 deg. This gives a useful control of the amount of air sucked through the walls, and hence of the boundary-layer thickness on the walls of the working section. Thus, as described, the best conditions for eliminating shockwave reflections from the walls at low supersonic speeds can be obtained.

Model Carts. A minimum disturbance of the airflow around the model is ensured by mounting the model by means of rear stings. The sting is pivoted downstream on a vertical strut mounted on a four-wheel carriage. This carriage forms the complete model cart (see Figs. 5 and 6) and, together with strut and model, can be run on rails in or out of the tunnel.

The front part of the vertical strut which includes the sting pivot is moved up and down by a lead screw driven by an hydraulic oil motor. The end of the sting opposite to the model is connected through a lever system to earth so that, when the front of the vertical strut is moved up or down, the incidence of the model changes while its vertical position remains approximately constant. The cart has been designed for an incidence range of plus 22 deg to minus 10 deg, maximum lift load on the model of 6,000 lb and a side force of 2,000 lb.

A rolling mechanism has been designed to fit into the sting just ahead of the pivot. By rolling the model and then operating the incidence-change mechanism, angles of sideslip can be obtained and measurements of static lateral and directional stability can be made.

Half-models can be tested by mounting them on a smaller carriage which replaces part of the floor in the perforated section of the tunnel. This carriage takes the form of a four-component balance with a lever system to separate the lift, drag, pitching moment and rolling moment on the model. Instead of a normal weigh-beam to measure the forces, electrical resistance strain-gauges are used to measure the tensions in small links coupled between the lever systems and earth. These strain-gauge units are used for about one-fifth of the total range of balance, with drop-weights to cover the full range. A system of calibration weights is also installed inside the balance, which is designed to

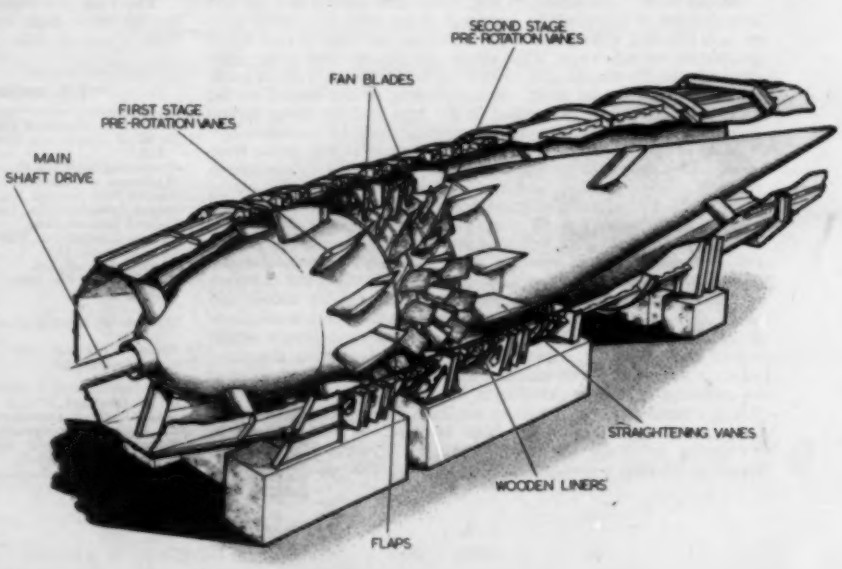

Fig. 4. The main fan, which is driven by a 25,000 h.p. A.C. slip-ring induction motor. The pre-rotation vane flaps give a second method of tunnel speed control.

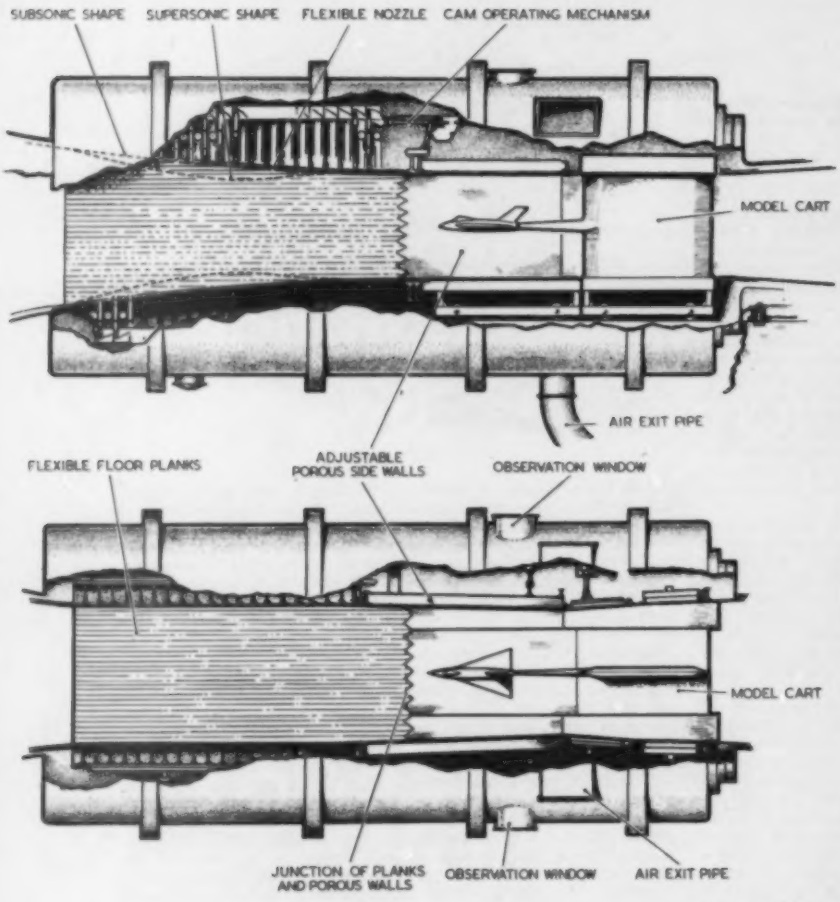

Fig. 5. Most novel feature of the transonic tunnel is the design of the working section, here illustrated, which is 9ft wide and 8ft high.

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measure lift loads of up to 6,000 lb, in order to check the strain-gauge units.

The half-model balance incorporates a solid floor which acts as a reflection plate. There is at present practically no experience of half-model tests in transonic tunnels and the technique of making such tests will need to be explored. No boundary-layer bleed is proposed at this stage, but this may be investigated later.

As well as measurements of overall forces on complete aircraft models work will be done on component parts of the aircraft. Hinge moments will be measured on control surfaces, again by using strain-gauges, and pressure measurements can be made both over wing and fuselage surfaces and inside air intakes.

Model Bays. As shown in Fig. 6 the first part of the diffuser downstream of the working section is fitted with retractable seals at each end and is mounted on a motorized carriage so that it can be moved out sideways. This allows the model carts to be withdrawn from the tunnel and pushed on rails through a set of turntables into the model bays. Initial rigging of the model on the cart can therefore be performed in the bays and, by using several carts, the delay caused by changing models can be minimized.

Most of the models to be tested in the tunnel will be made from steel. The air loads on the models are measured by electrical-resistance strain-gauge balances incorporated inside the model itself. The balances must be calibrated before the model is tested and a special calibration rig is provided in one of the model bays.

Control Room. The tunnel is started up and its speed is controlled from the main control room desk in the control room (Fig. 6). This desk also carries controls for operating the auxiliary suction plant, dryers, evacuation compressor, flexible nozzle and other items. Measurements of the forces on the models are made at another desk and the graph plotters and card punch which record the result are adjacent. For pressure-plotting measurements a multi-tube wall manometer, which can be photographed by means of F.24-type cameras, is installed at present. Although this is a rapid method of taking readings during tunnel runs, the subsequent evaluation of the films is slow. Other methods of measuring pressures are therefore under investigation, the aim being to develop a system enabling a graph plot of the pressure distribution to be obtained directly from the tunnel. A preliminary investigation of a pressure capsule using strain-gauges to measure the deflection of a thin diaphragm has already given encouraging results.

Although a window, incorporated in the working section pressure shell, enables the model under test to be observed from the control room, the view through it is limited to that obtained through the holes in the perforated plate. The introduction of a glass panel into the perforated plate itself would cause an unwanted flow disturbance and so a television camera is used, installed inside the pressure shell and viewing the model through one of the holes in the perforated plate. A receiving screen is fitted near the control panel.

Air Re-entry Section. The air which is sucked out of the working-section pressure-shell by the auxiliary suction plant is fed back into the tunnel circuit just downstream of the removable section. The air is ducted into a chamber surrounding the tunnel and is injected back into the tunnel stream through an annular slot approximately one inch wide. Although this quantity of air is small in relation to the main tunnel flow the injection through the slot serves to improve the efficiency of the main tunnel diffuser and reduce the power required by the main fan.

Main Fan Drive. The main motor of 25,000 h.p. is an A.C. slip-ring induction motor, speed-controlled by a liquid resistance. Coupled directly to the end of this motor is a D.C. motor capable of exerting a torque equivalent to 1,500 h.p. over the speed range of 250 r.p.m. to 485 r.p.m., which is the maximum speed of the A.C. machine. The power input into this D.C. machine is controlled by a Ward Leonard system using a D.C. generator driven by a synchronous motor.

Under normal running conditions the required speed is obtained by means of the liquid resistance with the power on the D.C. motor set to zero. When the required speed has been reached an automatic system is switched in so that a small change in the speed of the drive, due to an electrical or aerodynamic disturbance, operates an electronic servo system working from a tachometer and so alters the input into the D.C. motor and corrects the speed.

The fan is driven through a cardan shaft 37ft long coupled by two semi-flexible couplings so allowing for a certain amount of misalignment of the motor and fan shafts.

The oil circulation system, supplied and installed by Denco Engineering Services, feeds oil under pressure to each of the bearings in the fan and main driving motor. The oil is drawn from a 2,000 gal heated reservoir and pumped at 50 gal/min through a self-cleaning strainer and a cooler. All bearings are oil jacked, to reduce the torque at start-up by individual pumps.

The Fan. As illustrated in Fig. 4 the fan consists of two stages on the same shaft, each stage having 20 blades of 21ft diameter with a hub of 14ft diameter. First and second stages are pre-

A.R.A. MEMBERSHIP AND WIND-TUNNEL STAFF

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Blackburn and General Aircraft, Ltd. ...	N. E. Rowe, C.B.E.
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Westland Aircraft, Ltd.	E. C. Wheeldon
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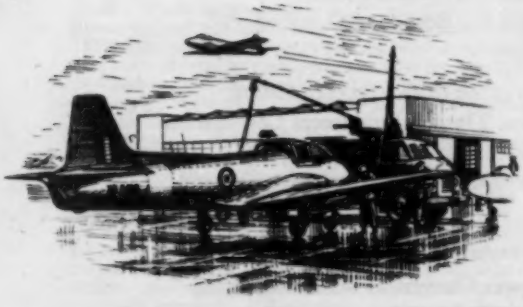
Secretaries.—J. V. Allen (1952-54), L. J. S. Dearlove, F.C.I.S.

Staff.—Chief executive, B. Hills, B.A.; chief aerodynamicist, A. B. Haines, B.Sc.; chief engineer, D. Grundy, A.M.I.Mech.E.

Consultants.—Architects, Lay, Colbeck and Partners; quantity surveyors, John Leaning and Sons; tunnel structure, W. A. Mitchell, M.I.Struct.E., M.I.W.; electrical equipment, A. N. Irons, M.I.E.E.

In Service with the Royal Air Force



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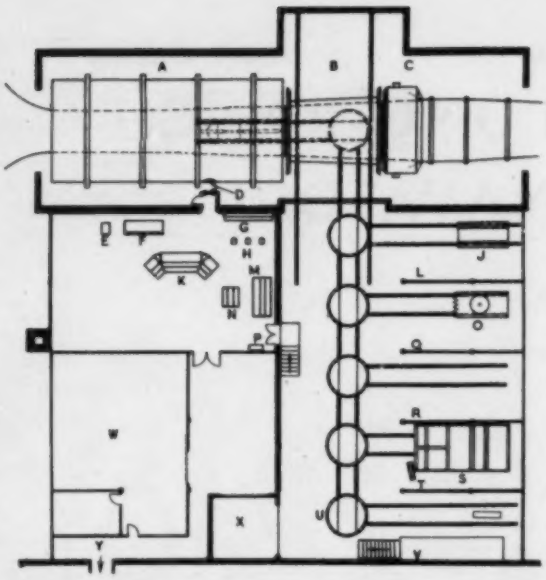

Fig. 6. Plan showing model bays, removable section of diffuser, and control room. Initial rigging of models on carts is performed in the bays.

A Pressure shell.
B Removable section.
C Air re-entry section.
D Observation windows.
E Machmeter.
F Flexible-wall control.
G Manometer.
H Cameras.
J Dummy-model cart.
K Control desk.
L Model bay 1.
M Strain-gauge balance console.
N Plotting console.
O Half-model cart.
P Gang punch.
Q Model bay 2.
R Model bay 3.
S Sting calibration rig.
T Model bay 4.
U Turntables.
V Model bay 5.
W Laboratory.
X Lift.
Y Offices

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ceded by eleven and 22 pre-rotation vanes respectively. Both sets of these vanes have flaps of some 25 per cent chord which can be adjusted from +10 deg to −20 deg from normal. An alternative method of speed control is thus obtained by altering the angle of flow into the fan, enabling the power output of the fan at a specified fan speed to be varied. Unlike the control of motor speed, little inertia is associated with these flaps and it is the intention that they shall be used to evolve an automatic speed-control system based on the tunnel Mach number.

The fan blades are made of Honduras mahogany covered with a sheet of glass fibre. The aerofoil length of the blade which is in the air stream is 3½ft and is faired into a rectangular section at the root. On two sides of this root section metal plates have been glued, using Araldite, and these plates are bolted on to the fabricated steel hub. A small adjustment (± 2 deg) of blade angle is possible. Each blade with its metal plates weighs some 200 lb, the centrifugal force at the hub at the maximum speed of 485 r.p.m. being about 40 tons.

Around the rectangular fan blade root are light-alloy fairings made up in a number of removable panels. At the outer hub fairing, which is 14ft in diameter, there is a centrifugal force of approximately 600g. Considerable difficulty was experienced in finding a satisfactory design to take these loads and the final arrangement incorporates a number of tie rods which take out the main centrifugal loads from the hub fairing.

Cooling System. The power put into the air by the fan and compressor is converted into heat and, since the tunnel circuit is a closed one, this heat must be removed by a cooling system. The main circuit has a cooler supplied by Head Wrightson Processes and consisting of ten elements, suspended from the tunnel ceiling and comprising four staggered rows of elliptical copper tubes fitted with rectangular fins. The cooler has been designed to reduce the tunnel air temperature from 62 deg to 50 deg C, to achieve which approximately 6,000 gal of water per minute is passed through the tubes at an inlet temperature of 25 deg C.

The cooler for the auxiliary suction plant is installed just downstream of the compressor and, supplied by Serck Radiators, is designed to cool 106 lb of air per sec from 216 to 50 deg C at a delivery pressure of 14.7 lb/sq in absolute, dissipating 27 million B.Th.U/hr.

Other coolers include the Denco cooling plant for the main slip regulator, dissipating some 3,500 h.p. The water is pumped through all these coolers by three 140 h.p. pumps to the top of a forced draught cooling tower and then falls into a reservoir of 200,000 gallons capacity.

Drying Plant. To avoid condensation shocks at high speeds the air in the tunnel must be subjected to a drying process. In the transonic tunnel a moisture content of 0.001 lb of water per lb of air—equivalent to some 10 per cent relative humidity at 50 deg C—is required. A Birlec Lectrodyrer, capable of maintaining this humidity against an infiltration of 5 cu ft/sec of air at 35 per cent relative humidity at 21 deg C, has been installed, together with two small auxiliary compressors to enable the tunnel pressure to be raised or lowered 1/5 atmosphere from atmospheric. The drying plant, through which air flows at a rate of 4 lb/sec, is of the dual-absorber type; operating on a 6-8 hr changeover cycle, one cylinder is employed while the other is being re-activated. Each cylinder contains 3,000 lb of alumina.

Recording of Measurements. The resistance-change measurements of the strain-gauges used in the model balances are made with a self-balance bridge unit employing a 625 cycle A.C. current to energize the system. A reading proportional to the force being measured is displayed visually on a drum and the readings are converted into electrical impulses for recording purposes by a digitizer, employing a cyclic progressive binary scale.

The electrical currents from the digitizer unit are then passed into a set of relays which converts into a system of currents in ordinary binary form. These relays are used for storage, each force or quantity being recorded having its own bank of storage relays. When the results are being recorded each storage bank is sampled in turn by a selector switch and is made to punch a Hollerith card.

The system which has been developed provides for six forces and moments and up to ten other quantities to be punched on one Hollerith card in just over half a second. To enable the operator to examine the results as they are obtained an automatic graph plotter is included; this operates from the binary impulses fed to the card punch and produces a plot of the loads on the model in normal decimal form against the wing incidence or angle of roll.

The graph plotter takes about 12 seconds to plot six components, during this time, however, the model incidence can be changed and the self-balancing bridges prepared for the next plot. The time taken to set up the storage relays is only 0.25 sec, after which time the operator is free to change the model incidence.

Computation of Results. In order to correct the raw data obtained from the wind tunnel to the form of coefficients directly applicable to the design of a full-scale aircraft, a number of arithmetical corrections and factors must be applied. One day's tunnel work can provide sufficient data to keep several persons operating normal electrical desk calculating machines busy for two to three weeks. To avoid this delay, an electrical calculating machine forms part of the A.R.A. installation. This machine takes the punched cards from the tunnel, performs all necessary calculations and produces another card punched with the corrected coefficients. To correct the results of a single six-component measurement, i.e., one input card, a total of about 1,000 multiplications, additions and subtractions have to be made. The

(*Concluded at foot of page* 547)

SUMMARY OF TRANSONIC TUNNEL AND PLANT PERFORMANCE

Tunnel		
Mach number range	...	0.6 to 1.3.
Working section size	...	9ft wide by 8ft high.
Pressure range	...	0.8 to 1.2 atmospheres absolute.
Weight flow of air	...	1½ tons/sec.
Main Fan Drive		
Fan	...	Two stages each of 20 blades of 21ft diameter and hub of 14ft diameter.
Maximum speed	...	485 r.p.m.
Main motor ...	...	A.C. slip-ring induction. Power: 25,000 h.p. for 2 hours, 20,000 h.p. continuous.
Auxiliary motor	...	D.C. direct coupled to A.C. motor shaft and used for accurate speed control. Power: 1,500 h.p. for 2 hours, 1,200 h.p. continuous.
Motor generator set	...	Generator, 1,600 h.p. output D.C. to drive D.C. motor. Motor A.C. synchronous; power 1,770 h.p.
Cooling Plant		
Water flow	... ...	600,000 gal/hr.
Water pumps	... ...	Three of 140 h.p., each giving 3,300 gal/min at 100ft head.
Auxiliary Suction Plant		
Compressor	... ...	Axial 11 stages. Volume flow, 300,000 cu ft/min; design pressure ratio, 3.2:1; speed, 3,000 r.p.m.
Motor ...	... ...	Synchronous 1,000 r.p.m. Power: 13,750 h.p. at power factor 1.0 for 2 hours; 9,900 h.p. at power factor 0.9 continuous.
Dryer Plant		
Dryers ...	... ...	Two similar plants with a rate of flow of 4 lb air/sec; capacity, 3,000 lb alumina each.
Evacuation compressors		Two 110 h.p. centrifugal compressors; flow, 3,500 cu ft/min at pressure ratio 1.2:1.
Trimming compressor	...	One 27½ h.p. centrifugal compressor; flow, 800 cu ft/min at pressure ratio 1.2:1.

LONG-RANGE NAVAIDS

Part 2: Dectra, Delrac and Navarho Systems

By J. H. GROVER, M.I.N.

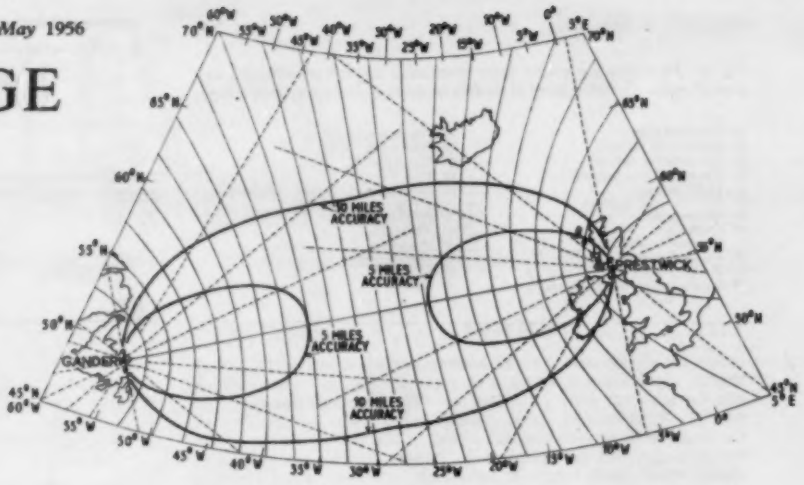


Fig. 1. The Dectra plan for the Prestwick to Gander route. The five- and ten-mile-accuracy contours are indicated, together with the tracking and ranging patterns. Approximately every ten lanes of tracking pattern and 100 lanes of ranging pattern are shown.

SINCE the first part of this article appeared, in last week's issue, it has been announced that the Decca company has received a contract from the British Government for the installation, with the co-operation of the Canadian Government, of Dectra transmitting stations in England and Newfoundland for their evaluation as a north Atlantic navaid. The proposed arrangement is discussed in this second and final instalment.

ALTHOUGH still to be evaluated or even tried, two British systems have, as previously mentioned, been selected by I.C.A.O. for development. These are Dectra and Delrac, and at present discussions are in progress between the Decca Navigator Company and the various official bodies concerned, aimed at installing an experimental Dectra layout covering the Prestwick-Gander route. Trials are expected to begin shortly, and the aid has reached an advanced stage of development. Delrac, however, remains a paper project for the time being.

Both Dectra and Delrac operate on hyperbolic principles, based on already well-established Decca techniques. This is of considerable importance, because it means that much of the evaluation necessary has already been accomplished. Let us in the first instance consider the way in which these Decca techniques have been applied to Dectra, and the way in which Prestwick-Gander coverage would be accomplished.

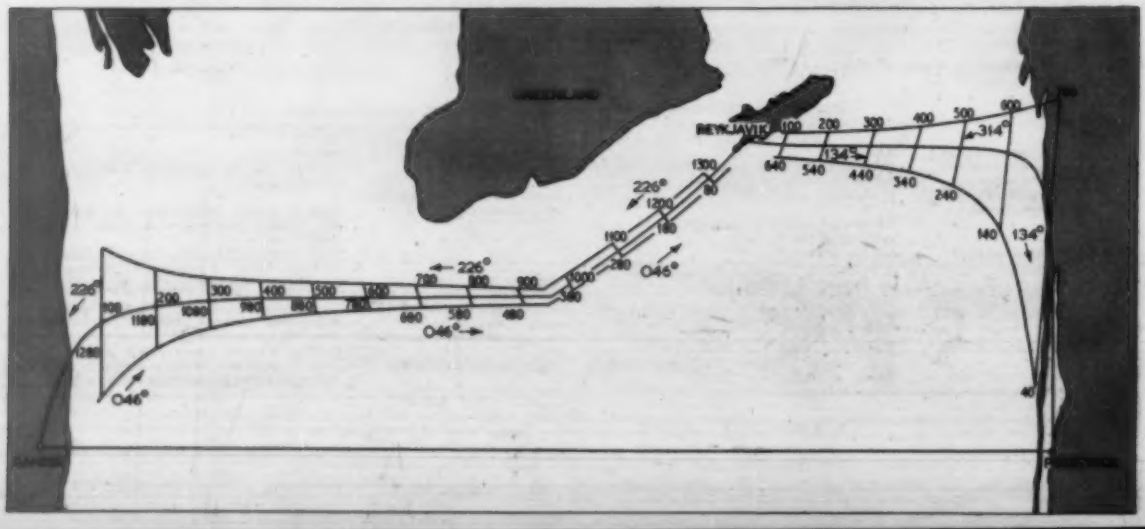
All Decca aids are hyperbolic, operating (like Loran) on the difference between master and slave transmission. However, unlike Loran, Decca measures the difference in phase between two transmissions in order to form a hyperbolic family of position-lines. Dectra is merely an adaptation of Decca to cover a specific route, whereas Decca covers an area.

To mark a route, or track, Dectra employs two pairs of transmitters, each pair straddling the track at either end. A pair consists of a master and a slave, and these are situated some 80 miles apart; the line joining the transmitters is called base-line. For various reasons the perpendicular bisector of the two base-lines should aim at coinciding as nearly as possible with the track. Perhaps the most important of these is the fact that the central member of a hyperbolic family is a straight line.

The master transmits a continuous signal with periodic interruptions. When these occur the slave radiates on the same frequency, having received from the master a short triggering pulse which corresponds to the lane-identification signal in standard Decca. Forming part of the airborne receiver is a highly stable oscillator, and a "memory" circuit effects comparison between the phases of the two transmissions. This enables the hyperbolic position-line appropriate to the position of the receiver to be computed and indicated. It will be appreciated that as a given track is being marked the main function of Dectra is a track-holding one, and therefore the reason for aligning the straight members of the two hyperbolic families with the track becomes apparent; normally only the hyperbolæ at the centre of the family are employed in this track-holding rôle, although the more curved members will afford excellent assistance off the required track. One pair of transmitters covers one half of the route, while the other pair covers the remainder. There is, of course, an area of overlap at the centre, and in this area the receiver frequency is changed to cover the second half of the route.

It will be seen, therefore, that the technique involves the propagation of two families of hyperbolæ, the centre members of which are similarly orientated within 180 deg. Now, in addition to tracking, Dectra also provides accurate ranging. This is accomplished in either of two ways. The first effects comparison of the phases of the transmissions between the two masters at a common comparison frequency. This results in the formation of a hyperbolic pattern lying across the tracking pattern; and by using the familiar comparative process the receiver is thus able to indicate not only the horizontal tracking hyperbolæ but also the vertical ranging hyperbolæ. In fact, if the line joining the two masters be considered as being similar to the base-lines mentioned earlier it will be seen that the ranging pattern aims at using

Fig. 2. An actual draft Dectra Flight Log chart. In this case a very small scale is used and the chart is drawn for the indirect Prestwick to Gander route via Reykjavik. This necessitates using the outer cover of the Dectra installation on the fringe of the 10 n.m. accuracy contour (see Fig. 1). Three tracks with a 20 n.m. separation are shown; operational charts would include latitude and longitude and diversion information.



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LONG RANGE NAVAIDS . . .

the short, nearly straight sections of its hyperbolæ at the baseline. In the event of the receiver being unable to receive both master transmitters, phase comparison then takes place between the transmissions from one master and a stable oscillator of known characteristics carried in the aircraft.

Dectra operates in the normal Decca frequency band and can be completely integrated with standard Decca. This even applies to the ground installation. For example, in the case of the Prestwick-Gander route the master and "purple" slave of the North British Decca chain would be used to fulfil the additional rôle of providing Dectra coverage for the eastern end of the route. This would, however, necessitate the re-siting of the purple slave, so that the master-slave base-line would be bisected by the Prestwick-Gander Great Circle track. A further pair of Dectra stations would, of course, be required in Newfoundland. Present indications are that an accuracy in tracking to within 5 n.m. should be obtainable over a route length of 1,600 n.m. with a proportionate increase at greater ranges. Ranging errors throughout the significant coverage should not exceed 5-10 n.m.

Although basically a meter-presentation system, Dectra information can be displayed by means of the Decca Flight Log. In fact, the same Flight Log and the same receiver may be used to receive and display standard Decca in addition, thus achieving complete integration of the long- and short-range components. A complete Flight Log chart roll can be made up covering the terminal areas, *en route* section, and diversion requirements. For the Prestwick-Gander route (see Fig. 2) this would consist of an ordinary standard Decca Prestwick approach chart based on the Decca North British chain, then a long *en route* section based on the two Dectra pairs. This *en route* chart would be marked with a number of eastbound or westbound tracks spaced at 1½-lane intervals. (A lane is the area bound by two in-phase hyperbolæ). This spacing represents a track separation of 30 n.m. at the centre of the route, reducing to 5 n.m. at 150 n.m. from the terminals. Marked along these tracks (which are numbered W1, W2, W3 or E1, E2, E3 and so on, according to whether westerly or easterly) are the miles to go to destination and the miles elapsed. The appropriate point at which to change over to the distant chain is also shown. In the case under discussion, assuming a westbound flight, this would be the Gander chain. Dectra accuracy reaches a very high order indeed near the transmitters, and accordingly the Gander approach would be made on a Dectra approach chart.

The scales of the approach charts would approximate to 7 n.m. to one inch, that of the *en route* Dectra chart being 10 n.m. to the inch. In addition, a 100 n.m. to the inch diversion chart would be included giving immediate diversion information to enable the most suitable alternate to be selected from any point. This chart could be superimposed in a contrasting colour over the *en route* chart to provide greater speed of action.

Delrac is a projected system that may be regarded as being a very-long-range version of Decca. Operating in the V.L.F. (very low frequency) band, Delrac is an area coverage aid. The name, like that of Dectra, is derived from the function—in this case Decca Long Range Area Coverage. The system is designed to provide high-accuracy position-fixing coverage for both aircraft and surface vessels on a global basis. For that matter, all the Decca systems described in this article are suitable for joint use, although in the case of Dectra there is the obvious qualification that the air and sea routes should coincide as nearly as possible. It will be readily appreciated that any system that has a dual application will be considered more favourably internationally, if only from the cold economical view.

The predicted performance of the Delrac system is such that it is estimated that 21 pairs of stations would provide world coverage, and all of these stations would be able to operate in the 10 to 14 kc/s band. Each pair consists of a master and slave, and by comparing the phases of the two individual transmissions from the stations of each pair whole families of hyperbolæ would result, one family to each pair of transmitters. An important point is the way in which the inherent Decca ambiguity has been eliminated by means of the superimposition on the pattern of secondary patterns, coarser by three, nine, and possibly twenty-seven times. Delrac presentation can be by meter and/or Flight Log; the meters would normally be carried to provide Flight Log setting data.

Navarho. Although normally the leader in most matters aeronautical, the United States have lagged some way behind in the development of navigational aids for civil aviation. There is, in fact, only one American system officially projected for long range navigation. Known as Navarho, it is developed from an area-coverage azimuth aid called Navaglobe, with the addition of rho, or distance information. Navarho provides full rho/theta—i.e. distance/bearing—information, and indicates these features to the pilot by means of meters. The maximum range is stated to be 2,000 n.m. with bearing accuracies of ½ to 1 deg and range accuracies to within 1 per cent of the distance. Thus, at 2,000 n.m., the range error may be anything up to 20 n.m. Navarho operates in the 90-110 kc/s band section.

The principle of operation calls for three aerials set up in the form of an equilateral triangle, the sides of which measure 0.36 of the operating wavelength. The aerials at each end of a side of the triangle are excited in turn for a given period and a set pulse rate. Thus, if we consider the three aerials to be lettered X, Y, and Z, we obtain a radiating cycle of XY, YZ, and ZX. Following radiations from each side of the triangle in turn all three aerials transmit simultaneously. This is a synchronizing transmission and takes place on an additional frequency at the same time. It is also used in the distance-measuring technique.

As each pair of aerials radiate, their transmissions are exactly alike in phase and amplitude, resulting in a radiation diagram like a figure eight. As the siting triangle is equilateral this will result in the pattern rotating through three separate positions 60 deg apart. There follows an omni-directional radiation from all three aerials. The airborne equipment receives these three patterns in sequence and notes the variation in the three amplitudes. Comparison of these amplitudes electronically is resolved into bearing information.

Following the reception of the three directional transmissions comes the "all-stations" dual-frequency pulse. A very highly stable oscillator is incorporated in the airborne receiver and comparison of its phase against the phases of the two frequencies transmitted by the ground stations is resolved into distance information. As the system is based on a triangle there is an ambiguity of 180 deg in the bearing component, but this is not a serious matter in a long-range system; in any case an ordinary A.D.F. receiver tuning down to the operating frequency will easily resolve it.

As mentioned, basic presentation is by means of meters giving the bearing and distance from the station. Additional equipment will allow for pictorial presentation, left-right indication showing divergence from a given track, together with ground speed, and autopilot couplers. The weight of basic Navarho is the same as that of basic Dectra—i.e. 70 lb—but the system cannot be integrated with a short-range aid.

Conclusions. In discussing the various aids little direct comparison has been attempted. This has been left until now because it is preferable to discuss with complete basic knowledge rather than to debate the pros and cons of each system during description. In the first place, we now have to consider the aids in the light of I.C.A.O. requirements. Quite obviously Consol and Loran fall far short of these requirements, not so much by virtue of their performance but because of their failure to provide an easily interpreted continuous presentation. Then, again, as a result, unless a track made good by a series of observations is extrapolated, the aids cannot be used for accurate track-holding—certainly without the accuracy required for lateral separation. Consol, however, possesses several advantages that should lead to its retention as a reserve system. Its ground installation is not critical, and is relatively inexpensive, but by far the most important factor is the complete lack of special airborne equipment. The ordinary A.D.F. or communications receiver in the aircraft is all that is required, and these receivers are normal equipment in any case. There is little likelihood of non-directional beacons going out of fashion in the foreseeable future, as they are likely to be kept as a secondary short-range aid to back up the chosen international standard. Therefore, Consol has no airborne weight at all, and may be integrated with a short-range aid. Loran requires the carriage of fairly weighty airborne equipment which cannot be used for any other purpose, neither can it be integrated with a terminal aid.

Dectra is completely integrated with normal Decca, the same receiver performing both functions. Furthermore, the addition of a Flight Log pictorial presentation is still common to both systems, whereas in the case of Navarho it would be necessary to carry additional equipment to cover the terminal stages of a flight. Navarho has a preferable meter presentation in comparison with the Dectra meters, which have to be referred to charts in order to be interpreted; but it is scarcely likely that Dectra would be used with meters alone, and with Flight Log the aid represents the most highly integrated navigational system of them all. The presentation is clear and easily understood, and a permanent track record from take off to landing is maintained. Decca has already been specified as the United Kingdom standard system for Airways and air traffic control; it can only be hoped that I.C.A.O. will recognize this and call on member states to base their A.T.C. systems on Decca. Otherwise, for transatlantic flights at least, this ideal integration will be wasted, as some other terminal aid will have to be carried for use at the far terminal; the U.S.A. is still rho/theta-minded and is far from keen on Decca. And last, but not least, the words of the Technical Committee of the International Air Transport Association must be considered—that present development of navaids lags five years behind development of transport aircraft. But here I.A.T.A. are a little unfair. It is not in the development but in the provision of navaids that the five-year lag occurs.

CORRESPONDENCE

The Editor of "Flight" does not hold himself responsible for the views expressed by correspondents in these columns; the names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

Rejuvenated DC-3s

I HAVE just laid down the recent issue of *Flight* which contained Mr. Dennis Powell's report on the apparently illimitable ability of Douglas DC-3 aircraft to accumulate hours in the air. Mr. Powell certainly covers the air hour totals of several veteran DC-3s interestingly.

As a postscript to his article, I would like to add that in the past several years a steady stream of operators in the United States have been installing in their DC-3s Wright R-1820-56 and Pratt and Whitney R-1830-75 and -94 engines producing 1,350 horsepower. (Transair, Ltd., of London, England, is just now making the first European installation of R-1830-94s in a DC-3.)

The resulting increase in power has not only permitted the "old lady" to cruise along at speeds of 200 m.p.h. and over, but has improved her rate of climb as much as 94 per cent in the first segment of take-off climb.

I recently staked my shirt publicly (in a paper presented at the Air Industries and Transport Association of Canada Convention at Quebec in November 1955) by stating that, in my opinion, DC-3s would shortly be rolling along at true air speeds of up to 225 m.p.h. at practically no more operating expense.

A specially "cleaned up" DC-3 two weeks ago made the trip from Inkster, Michigan, to Mexico City cruising at an average true airspeed of 228 m.p.h. at a direct cost per hour only slightly above that of most airline DC-3s cruising at approximately 165 m.p.h. Apparently, the career of the DC-3 is an awfully, awfully, long way from ending yet!

STEWARD-DAVIS, INC.
Gardena, California. F. H. Steward, President.

The Max Holste Broussard

WITH reference to the kind and interesting article on the Broussard which appeared in the March 23rd issue of *Flight*, I must admit that for somebody who had flown this aircraft for only one hour Mr. C. M. Lambert did pretty well in finding the faults and good points of the machine. As a matter of fact we have been checking the article against the official test reports by the Air Ministry, and altogether his conclusions run rather parallel to theirs.

There are a few details I would like to point out—proving, anyway, the keenness of his observations:—

(1) The flap control has been modified on production aircraft with a longer lever and a foolproof non-return switch.

(2) As far as the door is concerned, unless we provide a sliding door (very complicated, weighty and cumbersome) we have to keep this one. The lifting of the flaps for taxying is, anyway, part of the cockpit drill.

(3) On production aircraft the pilot seat is fully adjustable backward, forward and up and down, which improves considerably the comfort and visibility of the pilot.

Paris, 8ème MAX HOLSTE,
Avions Max Holste.

More-martial Air Marshals?

RECENT Russian influence appears to have affected the deliberations of the Clothing Committee (see page 438 of *Flight*, April 20th). Surely, the addition to the uniform of senior air officers of blue and gold sashes with 11in tassels and Soviet-type "cardboard" epaulettes is gilding the lily?

The present R.A.F. service dress, with the addition of aiguillettes and sword, formed a simple full-dress rig which stood out against the background of the Ruritanian Air Force uniforms of other countries. At this rate it will not be long before we see the R.A.F. back in its pre-war full-dress of cavalry overalls, steel fur-cased plumed flying cap and gold dog collar.

London, N.W.2. DAZZLED.

History of No. 830 Squadron, F.A.A.

WITH reference to the letter from Mr. Cox (*Flight*, April 13th), the date of No. 830 Squadron's arrival in Malta was June 1940—considerably earlier than stated in *Flight* (March 9th).

When the German attack on the Western Front began in May 1940, No. 767 Squadron was based at Hyères on the French Riviera for training duties, equipped with 18 Swordfish. In June, with Italy in the war and an armistice in France imminent, No. 767 flew to Algeria and divided into two flights of nine aircraft. One flight flew westwards to Gibraltar and the other made its way along the North African coast to Malta, arriving on June 22nd. The squadron number was then changed to 830 and the unit became an operational torpedo-bomber squadron, its first operation being flown on the night of June 30th. From that date onwards, 830 was Malta's Swordfish force with few reinforcements, six Swordfish of 821X Squadron arriving on January 8th, 1941, and a few aircraft from No. 825 in June 1941.

It is not correct to say that 830 Squadron took over 828 Squadron's Albacores, as 828 continued to operate from October 17th, 1941 (when it flew off *Ark Royal* to Hal Far) until July 1943, when it moved to Tunisia. No. 830's supply of Swordfish ran out in December 1942 and the remaining crews were transferred to 828. No. 830 Squadron finally disbanded on March 31st, 1943, but was reformed at Lee-on-Solent with Barracudas on May 15th, 1943, and subsequently operated from *Furious*.

The squadron was disbanded on September 21st, 1944, when it amalgamated with 827 Squadron.

London, E.12. J. J. HALLEY.

MAY I, as one of the original members of 830 Squadron of the Fleet Air Arm based at Hal Far in 1940, settle the question of its formation? Early in June 1940 two deck-landing training squadrons, 767 and 769, were stationed at the French Naval aerodrome at Palyvestre, near Hyères, in the South of France. With the rapid advance of the Germans across France and the imminent fall of the French Government it became imperative that the squadron should be evacuated. Thus, on the eighteenth of June at five o'clock in the morning, 24 Swordfish took off in two "waves" from Hyères. Four-and-a-half hours later they landed on the race-course at the little seaport of Bone in Algeria, 400 miles away.

At Bone, the aircraft were divided into two groups. Twelve of the better equipped machines were ordered to Malta, and the remainder were flown to Gilbraltar. The twelve destined for Malta took off for the island on the morning of June 20th, and after a stop for refuelling at the French Military Aerodrome at Medjez-el-Bab in Tunisia, arrived at Hal Far in the afternoon of the same day.

A few days later the personnel were informed that henceforth they would be known as 830 Squadron. The commanding officer at the time was an observer, Lt-Cdr. Francis D. Howie, and his senior pilot was Lt-Cdr. Garnett. I was at that time the C.O.'s air gunner. An anti-aircraft co-operation unit already stationed at Hal Far were absorbed into the squadron and for many months the flying crews were augmented by five R.A.F. air gunners—the only time, I believe, that R.A.F. air gunners flew operationally in Swordfish aircraft.

Incidentally, all twelve Swordfish of the original Squadron had flown from Donisbristle in Scotland early in the year. From Donisbristle to Malta must be the longest trip made by any Swordfish, although in 1941 I was with 813 and 824 Squadrons of H.M.S. *Eagle* when they flew 1,300 miles from Alexandria to Port Sudan *via* Wadi Halfa and Atbara, in two days.

Bournemouth, Hants. KENNETH C. C. BOWMAN
(ex-C.P.O.(O.) R.N.)

FORTHCOMING EVENTS

May 3-4. Canadian Aeronautical Institute: A.G.M., Montreal.
May 3-5. Institute of Welding: Spring Meeting.
May 9. Kronfeld Club: "On Cumulus Clouds," by Dr. R. S. Scorer.
May 9. R.Ae.S.: All-day Section Lecture on Supersonic Flight. Speakers: A. Y. Cleaver, F.R.Ae.S.; P. J. Duncton, B.Sc., D.I.C., A.F.R.Ae.S.; D. J. Farrar, M.A., A.F.R.Ae.S.; H. H. Gardner, B.Sc., F.R.Ae.S.
May 10. R.Ae.S.: Graduates and Students Section: "Some Thoughts on Present-day Aircraft and the Future," by Sir Frederick Handley Page, C.B.E., Hon. F.I.A.S., Hon. F.R.Ae.S.
May 11. Helicopter Association: Film Show presented by Capt. R. N. Liptrot, C.B.E., B.A.
May 12. Surrey Flying Club: Anniversary Party.
May 12-14. Channel Islands Aero Club: International Rally.
May 15. R.Ae.S.: Section Lecture: "Medical Aspects of Flight Comfort and Efficiency," by Dr. A. Buchanan Barbour, O.B.E., M.R.C.S., L.R.C.P., F.R.Ae.S.
May 16. Institute of Navigation: "Ballooning," by C. H. Gibbs-Smith, D. H. Harrison, C. S. Durst.
May 16. Lympne Airport At Home.
May 16. Kronfeld Club: Film.
May 17. R.Ae.S.: The 44th Wilbur Wright Lecture: "The Aerodynamic Art," by Sir William S. Farren, C.B., M.B.E., F.R.S., F.R.Ae.S.
Sept. 3-9. S.B.A.C. Display, Farnborough.

R.Ae.S. Branch Fixtures (to May 28th)
May 7, *Halton*, "Ejection Seats, the First Decade," by W/C. J. Jewell. May 9, *Weybridge*, A.G.M. May 11, *Birmingham*, Radar and Kindred Pilot Aids. May 14, *Halton*, Film. May 16, *Glasgow*, "Soaring Flight," by A. H. Yates. May 28, *Halton*, Film.
May 17-19. F.A.I. Conference, Vienna.
May 21. R.Ae.C.: National Air Race, Yeadon.

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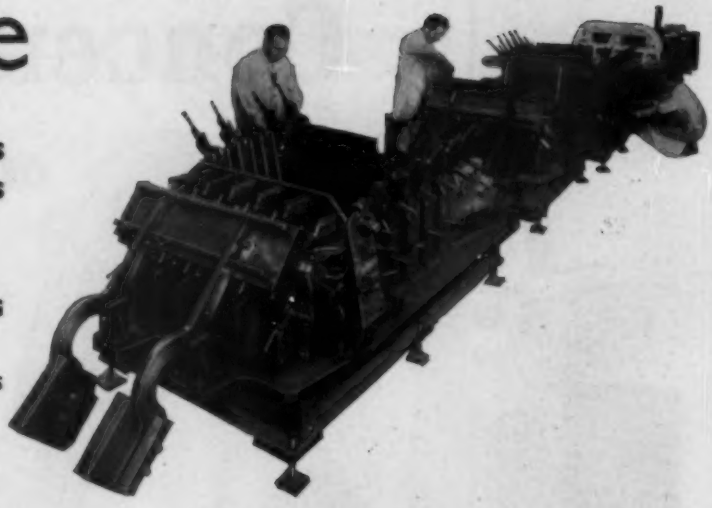

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TYPE FOW/A/1

Weight...	1 lb.
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Input Pressure (max.)	100 p.s.i.
Control Temp. setting	... 80°C.
Control Accuracy ...	... ±2°C.
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THE INDUSTRY

Dowty Group Directorship

AS already briefly noted in *Flight*, Mr. R. F. Hunt, A.F.R.Ae.S., A.F.C.Ae.I., has joined the Board of the Dowty Group. He went to Dowty's in 1935, as one of the company's first two apprentices. In 1939 he became a designer and in the following year was appointed chief instructor of the company's school of hydraulics, in which capacity he was attached to R.A.F. Technical Training Command. In 1944 he undertook technical liaison duties between Dowty's in England and in Canada and two years later was appointed export manager; it was then that he laid the foundations for the company's post-war expansion of exports. In 1949 he was appointed vice-president and general manager of Dowty Equipment of Canada, Ltd., and was especially concerned with the removal of the company's operations from the Montreal area to Ajax, Southern Ontario, where he founded the new company. He was made president in 1954 and will retain that position, making periodic trips to Canada in order to keep in touch with operations there.

Mr. R. F. Hunt

New Appointments in D.H. Propellers

IN keeping with the continued increase in the activities of de Havilland Propellers, Ltd., two new appointments have been made within the engineering team led by Mr. G. C. I. Gardiner, technical director and chief engineer. Mr. G. H. F. Brown, A.F.R.Ae.S., chief designer, is appointed assistant chief engineer; and Mr. C. C. Williams, who has been engineering manager since 1953, becomes engineering and general manager.

Mr. Brown joined de Havilland's propeller division in 1936 as a draughtsman and six years later, in 1942, went to Australia and set up a propeller design and development group within the Australian de Havilland Company. He returned to England in 1944, and in the following year was made assistant designer of the propeller division. In 1948 he joined the general engineering branch of Canadian Vickers, returning to de Havilland Propellers as chief designer in 1950. In his new capacity Mr. Brown will co-ordinate the technical activities of all drawing offices and laboratories engaged in work on airscrews, cold-air units, guided weapons and turbo-alternators.

Mr. Williams joined de Havilland in 1936 as a draughtsman with the propeller division. In 1940 he transferred to the engine division, where he ultimately became technical assistant to the chief inspector. Rejoining the propeller division in December 1945 as assistant manufacturing manager, he was appointed works manager three years later, and became engineering manager in March 1953. In his position as engineering and general manager, he will be responsible for overall co-ordination of de Havilland Propellers' development activities, and for the administration of the engineering departments at Hatfield, Stevenage and Edmonton, and in London.

Mr. G. H. F. Brown and Mr. C. C. Williams.

Shock-proof Mountings

THE firm of Cementation (Muffelite), Ltd., have received A.R.B. approval under Ref. E.3518 for their Type GB896 and GB780 ranges of "Barrymount" air-damped isolators. These shock-insulators are suitable for carrying loads of from 2 lb to 35 lb each, according to size. Standard isolators are designed to withstand a series of 15g shocks without failure, and a so-called "ruggedised" type is designed for 30g shocks. The isolators are intended for operation over a temperature range of −40 deg C to 70 deg C. The equipment is for instrument-panel, radio and comparable applications.

Electrical Control Gear

A PROFUSELY illustrated 114-page catalogue giving technical data on their industrial electrical control gear has been issued by M.T.E. Control Gear, Ltd., of Leigh-on-Sea, Essex. Standard equipment suitable for the more normal requirements of industry is dealt with in detail, and there is a general indication of the wide variety of control gear that can be manufactured to special design. Another M.T.E. publication is a brochure dealing with the Vari-Drive, a new system of infinitely variable speed control designed for operation on incoming 50-cycle A.C. mains and providing a control to a D.C. motor; from the user's point of view, it is stated, this equipment may be considered as the static counterpart of the Ward Leonard system, but offering considerable advantages.

IN BRIEF

Boulton Paul Aircraft, Ltd., report a net profit, to July 31st, 1955, of £408,243 before provision for taxation (previous year, £270,085).

* * *

Mr. Arthur Hillier, O.B.E., J.P., chairman and managing director of Sperry Gyroscope Co., Ltd., has been appointed High Sheriff of the County of Middlesex.

* * *

The Automatic Telephone and Electric Co., Ltd., and Marconi's Wireless Telegraph Co., Ltd., have concluded an agreement for co-operation in the field of telecommunications.

* * *

Mr. P. W. Parish, A.F.R.Ae.S., has joined Saben, Hart and Partners, Ltd., as chief designer of their aircraft division at 54-56, Old Christchurch Road, Bournemouth.

* * *

Mr. Frank A. Pope, C.I.E., has been appointed chairman of John Bull Rubber Co., Ltd., in succession to Mr. John C. Burton, who retired recently. The Board has conferred upon Mr. Burton the title of honorary president in recognition of his 50 years' service since he founded the business in 1906.

* * *

The Hymatic Engineering Co., Ltd., Redditch, Worcestershire, announce the appointment of Mr. J. B. Jay, A.M.I.Mech.E., as manager of their recently-formed automation division. His successor as chief designer, Mr. F. D. Brownhill, A.M.I.Mech.E., has been promoted from within the organization.

* * *

From Field Aviation Co., Ltd., Municipal Airport, Oshawa, Ontario, comes an impressive 186-page loose-leaf catalogue, describing in great detail, and illustrating, many hundred different aircraft components and accessories. It is Field's claim that they are "geared to service, overhaul or modify any aircraft from a Beech to a B-17."

* * *

The international Hinshaw Trophy was recently presented to the Goodyear Tyre and Rubber Co. (Great Britain), Ltd., in recognition of their record of the lowest number of disabling industrial accidents in 1955 for all Goodyear factories outside the U.S.A. Sir George Barnett, H.M. Chief Inspector of Factories, made the presentation. Out of a total of 7,310,000 man-hours worked, Goodyear factories in Britain suffered only four disabling accidents.

* * *

Mr. E. A. Murphy, M.Sc., F.R.I.C., F.I.R.I., general development manager at the Dunlop research centre, has been appointed director of research in charge of the company's central research division. Mr. Henry Trevaskis, A.F.R.Ae.S., chief designer to the aviation division and director of the Dunlop Rim and Wheel Co., Ltd., has been appointed director of development in the new organization. Mr. Trevaskis is particularly well known for his development of gun firing controls.

Club and Gliding News

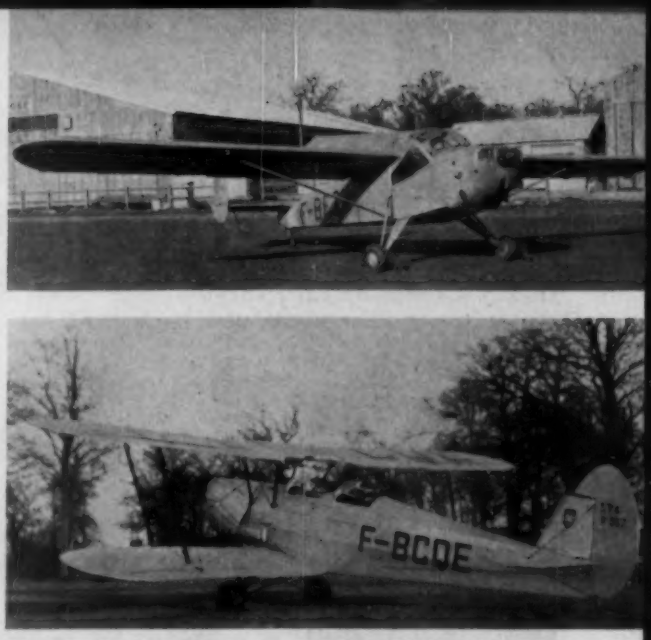
SHAPE FLYING CLUB

WITH the object of bringing together those members of the Allied armed forces stationed at Supreme Headquarters, Allied Powers Europe, Paris, who were interested in private flying, the SHAPE Flying Club was formed in November 1953 under the presidency of General Lauris Norstad, U.S.A.F. During the past 2½ years of operation the club has made steady progress, despite language differences and widely differing customs. On the social side, the club's activities have contributed much to the goodwill and understanding which exists among all ranks of SHAPE, who affectionately refer to the club as the "SHAPE Air Force."

The club owes its origin to the work of a few keen Allied Air Force officers and the generous help given by the French Ministry of Civil Aviation who, by making a loan of aircraft, enabled the club to overcome its most difficult problem—the lack of adequate finance for the purchase of equipment. Amongst other problems which had to be solved was a rather unusual one, as far as flying clubs are concerned, involving the laws of France. Since the majority of members were non-French nationals, the club was classified by the police as a "foreign association" and deemed subject to the laws governing such associations in France. These now rather ancient laws were designed to prevent foreign associations from plotting the overthrow of the French Republic and, as may be imagined, are hardly conducive to running a flying club. However, the club's honorary legal adviser, M. Jean J. Bertout, with the co-operation of the French Government, was able, after much negotiation and written assurance from high-ranking SHAPE officers, to obtain authority (possibly for the first time in French history) for a foreign association to operate private aircraft. Today the club is well established, has a membership of about fifty, and operates with three aircraft from the well-known private airfield at Villacoublay, 12 miles southwest of Paris.

The aircraft fleet consists of one Morane MS.230, a high-wing fully aerobatic open-cockpit monoplane; a Stampe SV4c, similar to the D.H. Tiger Moth; and an N.C.853.S, which is a high-wing, enclosed, side-by-side monoplane. All the aircraft are of French construction and have given most reliable service. The MS.230 and the Stampe are used for flying training, while the N.C.853.S is reserved for pleasure flying by pilot members.

Much planning went into paving the way for the establishment of the SHAPE Flying Club since S/L. William R. F. Cooney, R.A.F., club chairman, first conceived the idea for the organization. At the recent annual dinner, held at the "Rendezvous de la Chasse" near Paris, S/L. Cooney referred to the unique position of the club, reminding members that it was probably the only really international flying club in the world. Representatives of the majority of the 15 member nations of NATO could be found in the membership list, and it was pleasant to be able to welcome a representative of the Federal German Army, Lt-Col. Max R. Schwerdtfeger.



Two of the aircraft operated by the SHAPE Flying Club at Villacoublay: (top) the N.C.853 and (bottom) the Stampe SV4. These machines were presented on loan to the club by the French Minister of Civil Aviation.

Reviewing the club's activities during the past 12 months, the chairman was able to congratulate James Schauer (hon. treasurer and a founder member), U.K.; John Doerr, U.S.A.; Jean Drummen, Netherlands; and Robert Chagnat, France, on obtaining their Private Pilot's Licences. On behalf of members the chairman thanked the committee for their hard work during the past year, particularly the chief flying instructor, W/C. John D. Sidebottom, A.F.C., R.A.F., and his able assistant, M.Sgt. Robert Alexander, U.S.A.F. The chairman also referred to the encouragement given to private flying in France: that country, he thought, was the only NATO State having a government department devoted to the promotion of private flying; while the recent decision to remove all tax from fuel used by private aircraft had brought flying within the reach of a wide range of the population.

During the coming year several members of the SHAPE Flying Club are planning to make goodwill flights to neighbouring NATO countries, and the club would be glad to welcome members of other flying clubs visiting Paris. Inquiries should be addressed to the secretary, Mlle. Hélène Olivier, Intelligence Division, SHAPE, Paris.

AN informal discussion meeting to review progress and suggest future plans was held at the Kronfeld Club, 74 Eccleston Square, London, S.W.1, on Wednesday, April 25th. Some 60 members were present. In addition to the Wednesday evening general-interest talks and film shows, which have proved extremely popular, it was suggested that specialized instructional lectures should be held at the club on Thursdays. The building-up of a reference library of aeronautical books was also proposed. As many members now begin their weekend flying on Friday evenings, the club will be open during the summer season on Monday, Tuesday, Wednesday and Thursday evenings only.

AT Croydon Airport on Saturday last, April 28th, the six winners of the W.J.A.C. scholarships for 1956 were introduced to Lord Brabazon of Tara and to the chief flying instructors of the clubs where they will train. The occasion was the naming by Lord Brabazon of Auster Aiglet *Grey Dove II*, the new W.J.A.C. aircraft which has succeeded the Corps' Fairchild Argus *Grey Dove I*. The winners of the scholarships are Valerie Weller, Anne Marsden, Francesca O'Kane, Peggy Nye, Isobel Jones and Sylvia Quenet, whose scholarships have been respectively sponsored by the W.J.A.C.; Lea Bridge Industries, Ltd., Southend; E. K. Cole, Ltd., Southend; Gough Cooper and Co., Ltd., Dartford; Phoenix Grinding, Ltd., Birmingham; and Leon M. Berner and Co., Ltd., Birmingham. Flying training will be carried out at Fair Oaks Aero Club, Southend Municipal Flying School and the Midland Aero Club, Elmdon.

RECENTLY formed at Stapleford Tawney Aerodrome, Essex, is the works flying group of Edgar Percival Aircraft, Ltd. Operating Tipsy Trainer G-AFWT (formerly owned by the Home Counties Flying Group), the group expects its flying charges which will cover fuel and oil costs, to be £1 5s per hour.

FAIR OAKS Aero Club logged 4,700 flying hours and gained 90 P.P.L.s during the twelve months ended March 31st. A club flight to Beauvais, involving the available fleet of six Tigers and two Austers, is planned for Sunday, June 24th.

ENTRIES for the World Gliding Championships at St. Yan, France, from June 29th to July 13th, have been received from a total of 27 countries. They are South Africa, Germany, Argentine, Australia, Austria, Belgium, Brazil, Canada, Denmark, Egypt, Spain, U.S.A., Finland, France, U.K., Hungary, Israel, Italy, Japan, New Zealand, the Netherlands, Poland, Sweden, Switzerland, Czechoslovakia, Turkey and Jugoslavia. A maximum of three sailplanes may be entered by each country, although several countries have entered only one. One sailplane (Bréguet 901 or Air 102) will be loaned by France to the teams of thirteen of the competing countries. The British team will comprise Philip Wills and Geoffrey Stephenson (each flying a Slingsby Skylark 3 in the single-seater class); and Nick Goodhart and Frank Foster (Slingsby T.42B) in the two-seater class.

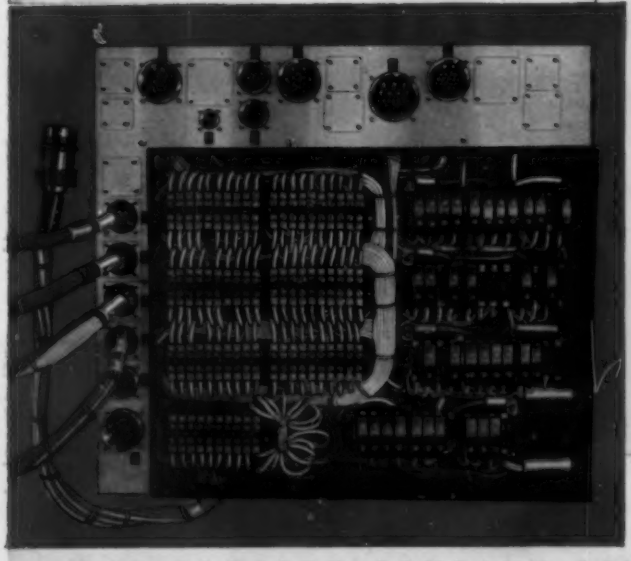
Accommodation for 800-1,000 people, in chalets and tents, is being arranged at the St. Yan centre where, during the championships, 20 towing aircraft will be in use. For the championships to be valid, a minimum of three competition tasks must be successfully completed, including one free-distance flight and one out-and-return flight to a nominated goal. Additional tasks which may be set include races over specified triangular courses of 100, 200 and 300 km.

GLIDING activity at clubs and centres in the Netherlands during 1955 accounted for 48,403 launches and 7,237 hours—both figures being substantial improvements over the previous year's results. A total of 116 sailplanes and gliders, including Slingsby Sedberghs, Prefects, Skys and Skylarks, are registered.

THE JAVELIN

RELIES ON Plessey

JUNCTION BOXES



The box illustrated—one of the seventeen Plessey junction boxes employed on every Javelin—has 242 separate wires, 439 crimped joints, 19 outlets and uses 740 feet of cable.

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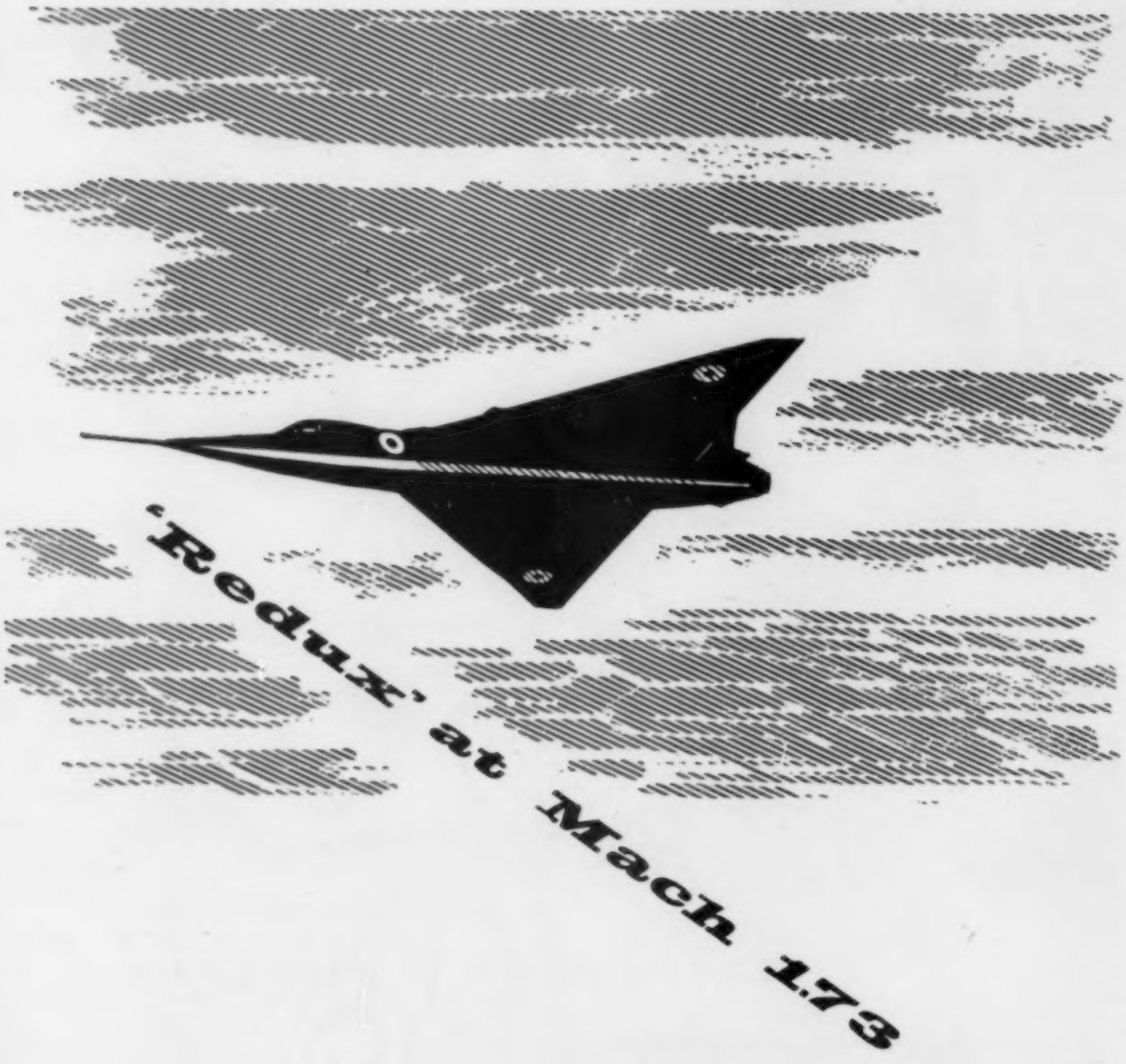

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CIVIL AVIATION

B.O.A.C. PILOTS' OUTBURST

SOMETIMES the shrewdest judgment of an organization's management comes from senior men within; when they go so far as to protest publicly in bitter terms about a new appointment, the circumstances cannot be disregarded. Last week an open letter written anonymously to the Minister of Transport and Civil Aviation (copies were sent to the Press and to selected Members of both Houses) by 12 men styling themselves senior B.O.A.C. pilots, in protest against the new Corporation appointments, was vehement in the extreme. So unusual is this outburst on the part of 12 presumably responsible men that we at once wonder whether their views are at all representative of those of other B.O.A.C. captains, of which there are some 280.

The feelings of the senior pilots—whether first- or second-class is not stated—no doubt go deeper than the matter of present appointments, and this is certainly not the first occasion upon which aircrews have indicated their belief that practical flying men should figure among the top executives of the Corporations. To put it another way, they naturally feel that men from their own ranks should have a chance of promotion to senior executive level. Captains are not necessarily all suited or qualified to take on senior executive positions when they cease to become active in the air, but it seems to them that they are not even considered. Again, to bring in outside men and place them over the heads of all others in a large organization—particularly when their qualifications could be in doubt—is tantamount to the Minister admitting that, after consideration, no one has been found worthy of promotion from within. The fact that one of the new senior appointments is for part-time only may suggest to the Corporation staff that the top direction of their airline is being taken lightly.

We remarked last week that whatever appointments were made they were bound to be opposed in one quarter or another. Everyone expected as much when Sir Miles Thomas resigned. One wonders if the pilots of B.O.A.C. were given an opportunity in advance of the new appointments to warn against the dangers of what they term "inept handling." We fear that their tirade in retrospect will do little good for their cause. The Minister would be faced with the possibility of resignation and the worsening of an already-bad situation should it be necessary to think again about these appointments. If the views of the 12 pilots are at all representative, the position of the two men is not enviable.

We urge now that Mr. d'Erlanger and Sir George Cribbett be given a fair chance to show their worth in their very responsible new positions. We believe that with proper support at other levels the Corporation will continue to make good progress under their guidance. We hope also that the Minister, and in due course his successor, will not overlook the legitimate claims for consideration of responsible senior pilots in the Corporation when executive positions are in question.

Below we give the gist of the letter addressed anonymously to the Minister of Transport and Civil Aviation, and in addition, some comments by Sir Miles Thomas at a farewell luncheon with the senior staff of B.O.A.C. last Friday.

"We, twelve senior pilots in this Corporation, have noted with dismay the completely inept handling of the two recent senior appointments in B.O.A.C. and wish to record that we think that nothing but trouble can follow if the affairs of a great national airline are to be handled by a part-time Chairman . . . and a Deputy Chairman whose last experience of practical flying was nearly forty years ago. . . . We have all been flying with the Corporation for many years and want to serve it in the future, but we see no reason for encouragement when its affairs, already . . . handled by a clique of aged Air Marshals, are handed over to a . . . banker and a retired Civil Servant. Please Sir, think again, before it is too late. Give us the tools and the men (we have them) and we will do the job. If not, anything may happen."

At the luncheon referred to above, Sir Miles Thomas thanked the senior staff for the co-operation and support given to him during the past six years. Referring to the pilots' letter, he said: "I am sure that you will agree with me that this kind of thing is to be deplored, as it is not likely to effect any change in the appointments which have been made by the Minister and does not, I believe, reflect the opinions of the pilots as a whole."

Adding that the new chairman and deputy chairman would look for loyal support from the senior staff, Sir Miles said it would be "unfortunate if undesirable publicity of this sort should impair relationships from the beginning".

At the moment of going to press, it is officially confirmed that Mr. Basil Smallpeice has been appointed managing director of B.O.A.C.

Significantly, representatives of the U.S. Civil Aeronautics Administration, the body responsible for the award of American certificates of airworthiness, paid a visit to Bristol Aircraft at Filton last week. The picture shows Mr. F. Wright, Britannia assistant designer (left) with Mr. R. K. Crothers of C.A.A.'s London office. Mr. R. E. Hardingham, chief executive of the A.R.B., was with the party.

B.E.A. WELL IN THE BLACK

WITH the end of the financial year (March 31st) passed, British European Airways have published preliminary trading results. These show that a net profit—the gross surplus after deduction of £600,000 of interest, depreciation, fuel tax and so forth—is about £500,000, compared with the previous financial year's net profit of £63,000 (the first in the Corporation's history).

Anticipating "our biggest summer yet," Lord Douglas estimated that each of the Corporation's Viscounts would earn about £47,000 a month throughout the season, and each Elizabethan £35,000. B.E.A.'s drive to increase freight business is yielding "really worthwhile results": cargo traffic was 32 per cent higher than last year, and the month of March showed an 86 per cent increase in domestic freight compared with the previous March.

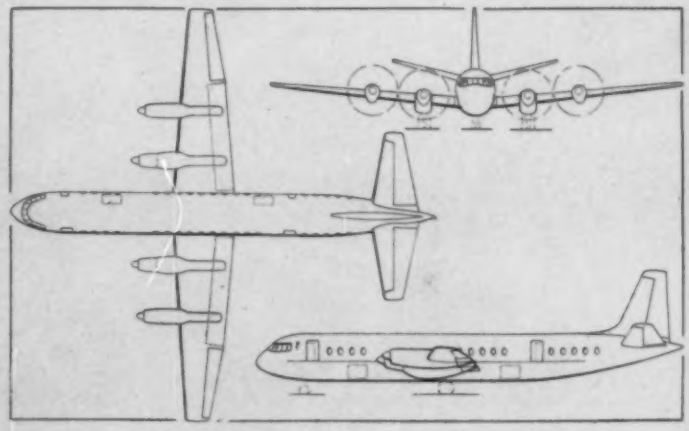
LUFTHANSA'S 707 ORDER CONFIRMED

AS predicted in *Flight* for March 23rd, Deutsche Lufthansa has placed an order with Boeing for four 707-320 jet airliners. The first three will be delivered in time for the German airline's summer services in 1960, and the fourth will be delivered for the 1961 peak season. The aircraft will be powered by Pratt and Whitney JT4s (J75s) and will have accommodation for 125 to 130 passengers.

The news was given by Lufthansa's technical director Gerhard Hoeltje at a lunch in Chicago to mark the German airline's new Chicago service *via* Manchester, inaugurated on April 24th.

AIR FRANCE'S COMET 1As

AIR FRANCE'S three Comet 1As, two of which have been idle at Le Bourget since April 1954, have been sold to the Ministry of Supply. The price paid for them is reported to be about £80,000 each and the two aircraft in Paris are due to be flown back to this country shortly. No indication of their precise future rôle has been given by the Ministry or by de Havilland, but the M.o.S. are paying £560,000 to include the cost of pressure-cabin modifications and the payments to Air France. Air France's third Comet 1A has been in storage at Hatfield since it was flown to England for a proposed drooped leading-edge modification early in 1954. It is understood that the French airline is to seek arbitration on its claim for further compensation. Two other French Comet 1As, those of U.A.T., are not included in the Air France arrangements.



The first official general arrangement drawing of the Vickers Vanguard. Main dimensions are: span, 118ft 7in; length, 118ft 1in; height, 34ft 11in; wing area, 1,527 sq ft. New Vanguard performance estimates are referred to on the next page.

Lloyd Aero Colombiano, who have three of these Curtiss C-46 Commandos fitted with auxiliary under-wing Turboméca Palas jets, will be familiar to readers as one of the airlines who, a year ago, announced their intention to buy Handley Page Heralds. On page 530 we describe the new "Super Commando."

CIVIL AVIATION . . .

NEW VANGUARD DISCLOSURES

SINCE Vickers-Armstrongs Aircraft announced preliminary figures last October for the Vanguard, 20 of which are on order for B.E.A. for delivery in 1959, development has reached the stage at which it becomes possible to enlarge on the aircraft's estimated performance. A significant item is that cruising speed, previously announced as 400 m.p.h., is likely before 1963 to go up to 425 m.p.h.—a measure, no doubt, of the power increases to be expected from the Rolls-Royce Tyne, which is likely to enter service at an initial 4,000 s.h.p.

Still-air range with the design maximum payload of 21,000 lb will be 3,150 st. miles without fuel reserves, or 2,600 st. miles with reserves (one hour's holding at 5,000ft, diversion for 230 st. miles, and a five per cent overall route reserve—this latter allowance applying also to the still-air range). So far as take-off is concerned the Vanguard will, at its maximum take-off weight of 135,000 lb, be able to operate from a 3,000 yd runway in standard atmosphere conditions. Other data are as follows: max. landing weight, 108,500 lb; max. zero fuel weight, 98,000 lb; max. payload (limited by zero fuel weight), 23,000 lb; seating (first-class) 76, (European tourist class) 93; fuel capacity, 5,100 Imp gal; total cabin volume, 5,894 cu ft; freight hold volume, 1,430 cu ft.

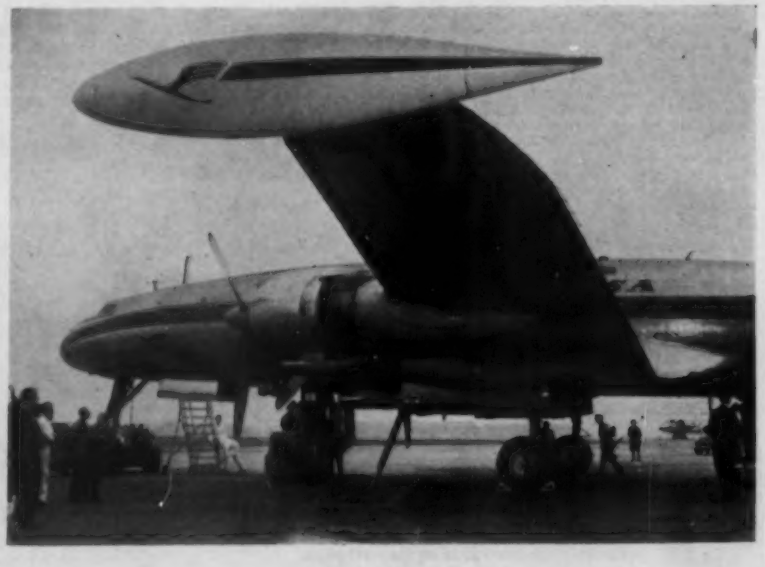
THE MINISTER'S PHILOSOPHY

SOME of the remarks of Mr. Harold Watkinson, Minister of Transport and Civil Aviation, at a luncheon given by the Foreign Airlines Association at the Dorchester Hotel, London, on April 26th, are worthy of quotation, as they were made by the Minister after receiving the criticism of his B.O.A.C. appointments, but before receiving the pilots' letter (previous page).

B.O.A.C. and B.E.A. were, he reasoned, competitive international businesses whose duty it was to fly good aircraft and to try to give a little better service to their customers than their competitors. To do this they needed the best brains and the best air transport experience, because the airline business was, after all, still a very personal business run and operated by men of individuality. "People, thank goodness, are still far more important than political theories."

He was not, he said, criticizing the past arrangements or achievements of the Corporations; but he did not believe that any one man could handle the rapidly expanding technical changes and international business. "I am not responsible for the day-to-day management of the Corporation . . . once one has achieved the right team one should leave them to get on with the job." It was of the greatest importance that there should be a clear ladder of promotion right through the Corporations to the top jobs—as an incentive to up and coming men, including aircrew.

It was, the Minister said, for the Chairmen to come forward with proposals for the aircraft that their Corporations needed for future operations, and it was his own duty to examine these proposals "in the broad national interest." This implied a withdrawal of his statement the previous week that B.O.A.C. would adopt a "fly-British" policy.



On board Lufthansa's Super-G Constellation (seen here) for its inaugural flight from Manchester to Chicago on April 23rd was the first citizen of Manchester, Alderman T. Regan, the Lord Mayor of England's northern capital. The service, which starts from Hamburg, is the "Manchester Midwestern."

CENTRAL AFRICAN'S FIRST VISCOUNT

THE ninth British Commonwealth Viscount operator took delivery of its first aircraft on April 25th. The occasion was marked by a small ceremony at the Vickers airfield at Wisley, where Mr. I. C. M. Hepburn, Central African Airways' representative at Vickers, took formal delivery of his airline's first Viscount 748 from Mr. George Edwards. The High Commissioner for the Federation of Rhodesia and Nyasaland, Sir Gilbert Rennie, was present. The aircraft (shown in the picture opposite) was YP-YNA R.M.A. *Malvern*, the first of five Viscounts of which delivery is due to be completed by the end of July. By that time, subject to Government approval, C.A.A. are likely to have become the first airline to employ Viscounts on a major intercontinental trunk route: on July 20th, the Rhodesian Viscount tourist service between London and Johannesburg is due to be inaugurated. Internal Viscount services will greatly speed up communications between Salisbury and such centres as Nairobi, Livingstone, Lusaka, N'dola, Durban, Elizabethville and Johannesburg. The training of C.A.A. flight and ground personnel has been under way for nearly two years at Vickers and Rolls-Royce.

It is reported from Australia that T.A.A. has decided to order two Viscount Major 800s for delivery in 1958. If this is confirmed it will be the airline's third Viscount repeat-order. T.A.A. now confirms its purchase, forecast in *Flight* of March 16th, of six Fokker Friendships.

BLACKBUSHE ACCIDENT FINDINGS

THE accident which occurred to B.E.A. Viscount G-ANOM at Blackbushe on January 20th during a training flight take-off was caused, states the M.T.C.A.'s accident report, by pilot error. A routine base check was being carried out by Capt. D. A. Longhurst, a training captain, on Capt. D. J. Turner. As the take-off safety speed was reached Capt. Longhurst simulated a starboard-outer engine failure; at this point the aircraft was just airborne, and it was observed that the starboard inner airscrew was seen to be stopping. The aircraft began turning to the right with an increasing amount of bank, finally hitting the ground 250 yd from the runway in a steeply banked nose-down attitude. It then cartwheeled and slid backwards for 200 yd. The aircraft was almost completely destroyed by fire, although only slight

Coming into the picture is the first Vickers Viscount 748, Royal Mail airliner "Malvern," for Central African Airways. Its delivery is the subject of a news item on the opposite page.

injuries were sustained by the five members of the crew.

The M.T.C.A.'s report concludes that the accident was due to an error by the training captain who operated number three engine's high-pressure fuel-cock lever when simulating a failure of number four engine, which resulted in loss of power from both starboard engines at a critical point in the take-off.

BREVITIES

A NEW B.E.A. service to Venice was inaugurated by a Viscount on April 22nd. Initially it will be operated four times weekly, in association with Alitalia.

* * *

The most interesting fact revealed by the Qantas 1955 traffic figures was the big increase—about 45 per cent—in tourist traffic.

* * *

K.L.M. made the biggest profit in its history last year—about £1.9m.

* * *

Sir Charles Bell is the name of the third de Havilland Heron —G-AMFY—recently delivered to B.E.A.

* * *

A merger is announced between the Navigators' and Engineers' Officers Union and the Marine Engineers' Association.

* * *

An Indian delegation is in London discussing amendments to the 1951 agreement between India and Britain which regulates the operations of Air-India and B.O.A.C.

* * *

A direct air link between Moscow and Brussels is likely to be the outcome of recently concluded talks between Sabena and Aeroflot.

* * *

B.O.A.C.'s all-turboprop flights between New York and the Caribbean and Bermuda have been inaugurated by the airline's associate B.W.I.A.

* * *

The latest product of the Vickers-Armstrongs plastics development department is a chair tray for the Britannia, claimed to be 50 per cent lighter than an ordinary wooden tray.

The Minister of Transport was due to be asked in the Commons last Wednesday whether he was aware of "moves among independent air operators to constitute a third or independent airways corporation: and if he will give such moves his support."

* * *

PanAm and T.W.A. have applied for permission to operate trans-polar services between the U.S. west coast and Europe. S.A.S. and C.P.A.L. are so far the only two airlines operating trans-polar services.

* * *

S.A.A. is to begin a weekly service to Australia in co-operation with Qantas, using Constellation L-749As tourist-class. When their third DC-7B is delivered first-class flights will begin.

* * *

Two important technical meetings are to be held by I.F.A.L.P.A., the International Federation of Air Line Pilots Association. The first, concerning ground aids, will be from May 8th-10th; the second, devoted to airworthiness, will be on June 7th and 8th.

* * *

Anyone looking for a guide to London Airport might well buy a copy of the booklet just published by Pitkin, price 2s 6d, *The Complete Guide to London Airport*, by Sir Miles Thomas. It includes a register and illustrations of the aircraft likely to be seen, as well as a complete pictorial record of the airport.

* * *

The Minister of Transport and Civil Aviation, Mr. Harold Watkinson, is reported to have said at Edinburgh: "We are making the largest-selling aircraft in the world, and I say without hesitation that this island still produces the best civil aircraft in the world. I say that with full knowledge of what other countries are doing."

THE A.R.A. TUNNEL (continued from page 539)

machine as used as present takes about one minute to do this, although a decrease in this time is anticipated with future modifications to the computor.

The card carrying the corrected data is next fed into a card reader which operates an electric typewriter to type out a table of the coefficients. At a future date a graph plotter is to be installed which will plot the graphs directly from the corrected cards.

CONTRIBUTORS TO THE INSTALLATION

The following list of firms whose products or services have been utilized in the installation is based on a list provided by the A.R.A.:—

Tunnel Structure.—Main tunnel shell, Moreland Hayne and Co., Ltd.; contraction cone, cooler structure, working-section shell, removable section, air-entry section, G. A. Harvey and Co. (London), Ltd.; working section, flexible nozzle, Chatwood Safe and Engineering Co.; corner vanes (light gauge), Caston Barber, Ltd.; gauze screens, George Christie, Ltd.

Buildings.—Main contractors, Robert M. Douglas (Contractors), Ltd. Steelwork, Moreland Hayne and Co., Ltd.; heating, Stitson, White and Co., Ltd.; electrical installation, Archibald Saville and Co., Ltd.; windows, Luxfer, Ltd.; roofs, D. Anderson and Son, Ltd.; 50- and 25-ton cranes, Herbert Morris, Ltd.

Main Fan Drive.—Main contractors, English Electric Co., Ltd.; A.C. motor, 25,000 h.p., and D.C. motor, 1,500 h.p., English Electric Co., Ltd.; 1,500 h.p. motor-generator set, British Thomson Houston Co., Ltd.; fan casings and stator vanes, G. A. Harvey and Co. (London), Ltd.; fan hubs, shaft and flexible couplings, Walker Bros. (Wigan), Ltd.; fan bearings, Michell Bearings, Ltd.; oiling system, Denco Engineering Services, Ltd.; blade shroud fairings, Williamson-Pinney, Ltd.; fan blades, Hordern-Richmond, Ltd.

Auxiliary Suction Plant.—Axial compressor, gearbox, British Brown-Boveri, Ltd.; 13,000 h.p. synchronous motor, English Electric Co., Ltd.; motorized valves, Rotork Engineering Co., Ltd.; ductwork, G. A. Harvey and Co. (London), Ltd.

Electrical Equipment.—Switchgear, control cubicles, transformers, motors, English Electric Co., Ltd.; cabling, British Insulated Callender's Cables, Ltd.; 415-volt starters, Allen West and Co., Ltd.

Cooling System.—Main tunnel cooling units, Head Wrightson Processes, Ltd.; auxiliary suction plant cooler, Serck Radiators, Ltd.; cooling tower, Film Cooling Towers (1925), Ltd.; water pipework, Simmons and Hawker, Ltd.; water pumps, Gwynnes Pumps, Ltd.; water-softening plant, William Boby and Co., Ltd.

Dryers and Auxiliary Plant.—Dryer, Birlec, Ltd.; coolers, F. H. Biddle, Ltd.; 110 h.p. and 25 h.p. compressors, Keith Blackman, Ltd.; 50 h.p. and 12½ h.p. evacuation pumps, Sir George Godfrey and Partners, Ltd.; valves, Robert Cort and Son, Ltd., Westwood and Wrights, Ltd., Saunders Valve Co., Ltd.; pipework, H. and G. Tube and Engineering Co., Ltd.

Tunnel Equipment.—Complete model cart, Chatwood Safe and Engineering Co.; half-model cart and balance, calibration gear, wall manometer, Test Equipment, Ltd.; computor, British Tabulating Machine Co., Ltd.; automatic strain gauge measuring units, Boulton Paul Aircraft, Ltd.; television cameras, Pye Radio, Ltd.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

The first Christchurch-built D.H.110 being prepared for catapulting from H.M.S. "Ark Royal" during deck trials last month. Noteworthy are the extending flaps, knife-edge windscreen and the reinforced bases of the fins. A picture of the N.113 on deck is on page 518.

No. 56 Squadron Standard

LAST Friday the Duchess of Kent presented a Standard to No. 56 Sqn. during a ceremony at Waterbeach, Cambs. In command of the parade was Maj. J. E. H. Kaisin, Belgian Air Force, No. 56 Squadron's C.O. The flights were commanded by F/L. J. V. E. P. Carter and Capt. C. G. Gillespie, U.S.A.F., an American officer on exchange posting. Music was provided by the Central Band of the R.A.F. and the standard was dedicated by the Rev. Canon A. S. Giles, Chaplain-in-Chief of the R.A.F.

D.H.110 and N.113 on Deck

LAST month the de Havilland D.H.110 and Supermarine N.113 successfully completed carrier landing trials on board H.M.S. *Ark Royal* off the south coast of England. The D.H.110 was flown from Boscombe Down to the carrier by Cdr. S. G. Orr, C.O. of the A. and A.E.E. Naval Test Squadron. Several other pilots also flew the aircraft. Free and catapulted take-offs, "touch and go" and fully arrested landings were tried in addition to handling on the deck and during the approach. The aircraft used was the first to be built by de Havilland's Christchurch works.

Cdr. Orr also flew the N.113 during the *Ark Royal* trials, together with "Mike" Lithgow, Lt-Cdr. C. M. Little and Lt. P. Whitehead, R.N. Altogether 29 landings were made, but all take-offs were made without catapult assistance. Before the trials the pilots had intensive A.D.D.L. practice at Boscombe Down. The N.113 had already been taxied at high speed into arrester wires installed on a runway at R.A.E. Bedford in order to obtain records of decelerations and strains on the airframe. At Boscombe Down 38 flights were made in ten days without any hitches.

The Freedom of Aylesbury

CONTINGENTS of all six units based at R.A.F. Halton, Bucks, marched with bayonets fixed, colours flying, drums beating and bands playing into Aylesbury on Tuesday of last week to receive the freedom of the Borough of Aylesbury from the mayor, Councillor W. T. Fewkes. Mr. Fewkes presented the Deed of Freedom to A. Cdre. G. N. E. Tindall-Carill-Worsley, the station commander.

Addressing the parade, Councillor Fewkes said that during the 40 years of Halton's existence the standard of behaviour of its men had been a shining example to youth of conduct away from their normal habitations. He liked to feel that Aylesbury was Halton's town and felt that it was fitting that the long, close and friendly relation should be recognized by Aylesbury. Freedom of entry was the highest honour a borough could bestow.

The Commanding Officer, replying, spoke of the long-standing friendship built up by those who had gone before and to the happy liaison with local industry and happy contacts in the field of sport. Two young Halton-trained men, he observed, had become the mayor's sons-in-law. Mr. Christopher Soames, Parliamentary Under-Secretary of State for Air, who also addressed the parade, said that an honour like the granting of freedom of entry meant a great deal to the R.A.F. as a whole. The link between Aylesbury and Halton was just what such a link between station and town should be, and an ideal example of the relationship that should exist.

The Queen's Standard for the R.A.F. in the United Kingdom and R.A.F. Halton's Standard being paraded through Aylesbury to mark the granting to the station of the freedom of the Borough on Tuesday of last week. The proceedings are reported on this page.

Change of Appointment

THE Air Ministry has announced that A.V-M. H. H. Brookes has been appointed A.O.C. No. 25 Group, Flying Training Command, with effect from April, instead of A.O.C. No. 61 Group, Home Command, as previously announced.

Beverley Overseas

THE Blackburn and General Aircraft Beverley which has just gone into service with the R.A.F. made its first overseas proving flight last week. A Service machine flew to Wahn, near Cologne, where it was shown to the R.A.F., officials of the German Defence, Economic and Foreign Ministries and representatives of Lufthansa and other civil operators. The aircraft was demonstrated by S/L. A. St. J. Price, C.O. of the Beverley unit at Abingdon. A picture of General Milch inspecting the aircraft appears on page 519.

A company statement on the event records that the demonstrators were "embarrassed as the airfield was over four times too big for the Beverley, and take-off and landing on the runway in use would have been practically invisible" from the spectators' enclosure. The aircraft backed off its hard-standing under its own power and turned round to taxy out. It took off on an out-of-wind runway in 450 to 500 yd and landed down-wind on the runway in use. Several take-offs and landings, a three-engined fly-past and a baulked landing were demonstrated and spectators are reported to have been considerably impressed.

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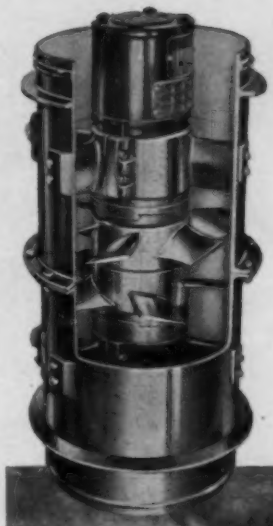

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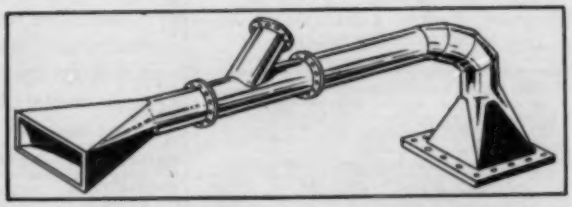

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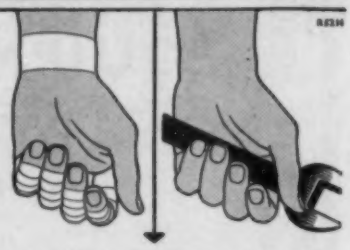

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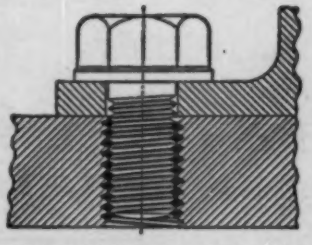

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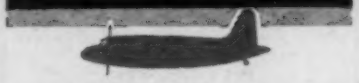

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PUBLIC ANNOUNCEMENTS

AIR TRANSPORT ADVISORY COUNCIL

THE Air Transport Advisory Council give notice that they have received the undermentioned applications to operate scheduled air services:

APPLICATION No. 781. From Eagle Aviation, Ltd., of Marble Arch House, 32/50, Edgware Road, London, W.2, for a Seasonal Inclusive Tour Service with Viking aircraft in conjunction with Sir Henry Lunn, Ltd., for the carriage of passengers and supplementary freight between London (Blackbushe) and Valencia (Monises) at a frequency of up to seven return flights weekly during the season from April to October inclusive each year, for a period of seven years, commencing 1st April, 1957.

FROM B.K.S. Air Transport, Ltd., of 1, Marylebone High Street, London, W.1:

APPLICATION No. 782 for a U.K. Internal Service with Dakota and/or Viking aircraft for the carriage of passengers, supplementary freight and mail between Belfast (Nutts Corner) and Isle of Man (Ronaldsway) at a frequency in accordance with traffic demand for a period of seven years, commencing 1st June, 1956.

APPLICATION No. 783 for a U.K. Internal Service with Dakota and/or Viking aircraft for the carriage of passengers, supplementary freight and mail between Belfast (Nutts Corner) and Blackpool (Squires Gate) at a frequency in accordance with traffic demand for a period of seven years, commencing 1st June, 1956.

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3, Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [5174

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APPLICATIONS which will be treated in the strictest confidence should be sent by Airmail to the Secretary, Cyprus Airways Limited, 36 Homer Avenue, Nicosia, Cyprus, so as to reach him not later than 15th May, 1956. [5169

DEVELOPMENT Engineers and Physicists are required for work in the new and rapidly expanding laboratories of Louis Newmark, Ltd., at New Addington, Surrey. The work includes the design and development of instruments and equipment for the aircraft and allied industries, and some working experience of small electromagnetic instruments is desirable. A degree or similar qualification essential. Good salary based on age and experience. Contributory Pension Scheme. Apply in writing giving full particulars to: Personnel Officer, Louis Newmark, Ltd., Prefect Works, Purley Way, Croydon. [5161

SAUNDERS-ROE LIMITED have a vacancy for an Instrumentation Engineer in their design department at Osborne, Isle of Wight. Applicants should have some knowledge of modern instrumentation techniques. Some knowledge of electronics and/or photographic process work would be advantageous.

The work is interesting and there are opportunities for advancement. Staff assurance and pension schemes are in operation and assistance with accommodation is available. Applications, quoting age, experience, salary required and reference F85 should be addressed to the Personnel Officer, Saunders-Roe, Ltd., East Cowes, Isle of Wight. [5157

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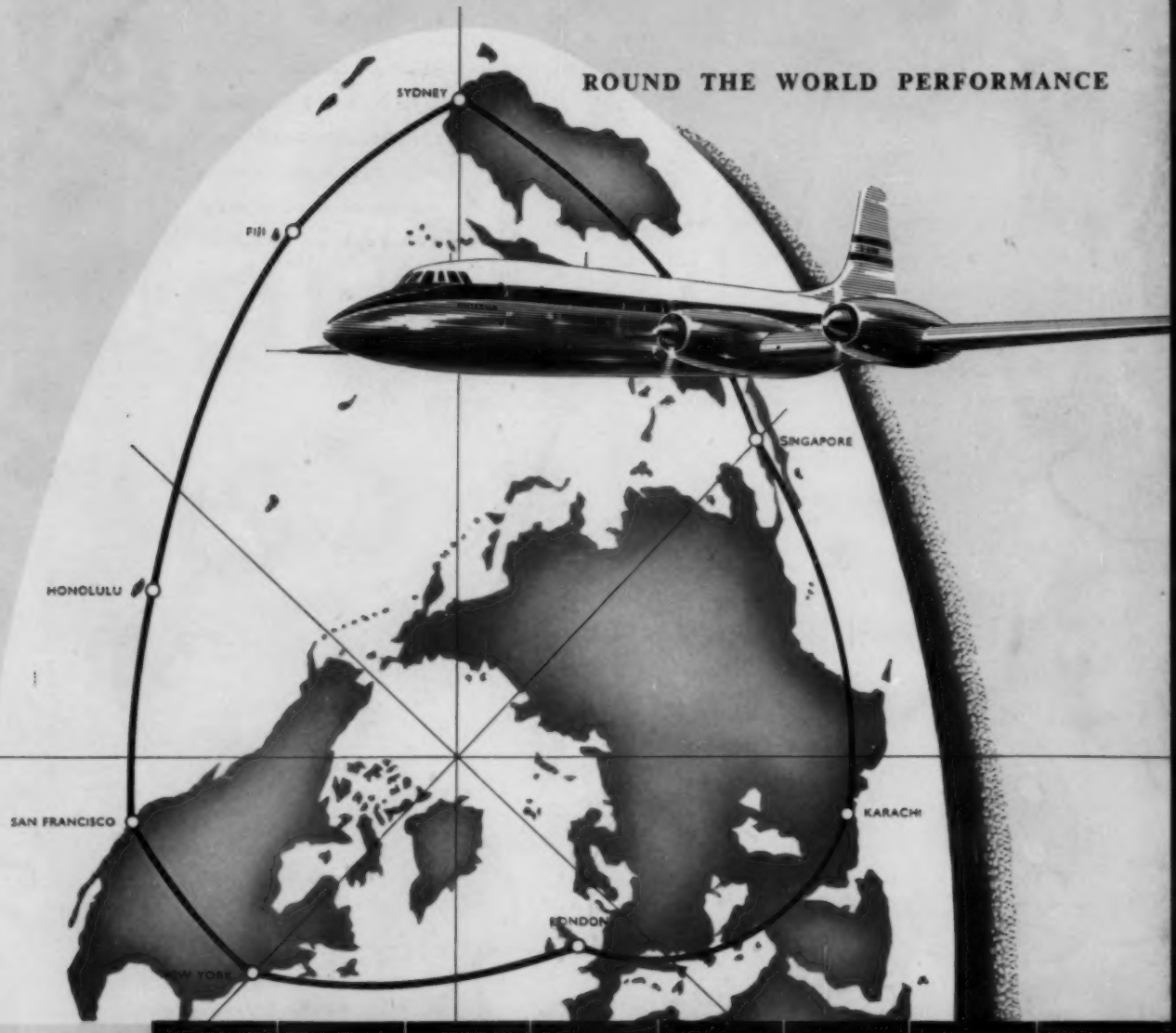

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